Herpetofaunal Inventories of the National Parks of South Florida and the Caribbean: Volume III. Big Cypress National Preserve

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Executive Summary

Amphibian declines and extinctions have been documented around the world, often in protected natural areas. Concern for this alarming trend has prompted the U.S. Geological Survey and the National Park Service to document all species of amphibians that occur within U.S. National Parks and to search for any signs that amphibians may be declining. This study, an inventory of amphibian species in Big Cypress National Preserve, was conducted during 2002 to 2003. The goals of the project were to create a georeferenced inventory of amphibian species, use new analytical techniques to estimate proportion of sites occupied by each species, look for any signs of amphibian decline (missing species, disease, die-offs, etc.), and to establish a protocol that could be used for future monitoring efforts.

Several sampling methods were used to accomplish these goals. Visual encounter surveys and anuran vocalization surveys were conducted in all habitats throughout the park to estimate the proportion of sites or proportion of area occupied (PAO) by each amphibian species in each habitat. Opportunistic collections, as well as limited drift fence data were used to augment the visual encounter methods for highly aquatic or cryptic species. A total of 545 visits to 104 sites were conducted for standard sampling alone, and 2358 individual amphibians and 374 reptiles were encountered. Data analysis was conducted in program PRESENCE to provide PAO estimates for each of the anuran species.

All of the amphibian species historically found in Big Cypress National Preserve were detected during this project. At least one individual of each of the four salamander species was captured during sampling. Each of the anuran species in the preserve were adequately sampled using standard herpetological sampling methods, and PAO estimates were produced for each

species of anuran by habitat. This information is valuable now as an indicator of habitat associations of the species and relative abundance of sites occupied, but it will also be useful as a comparative baseline for future monitoring efforts.

In addition to sampling for amphibians, all encounters with reptiles were documented. The sampling methods used for detecting amphibians are also appropriate for many reptile species. These reptile locations are included in this report, but the number of reptile observations was not sufficient to estimate PAO for reptile species. We encountered 35 of the 46 species of reptiles believed to be present in Big Cypress National Preserve during this study, and evidence exists of the presence of four other reptile species in the Preserve.

This study found no evidence of amphibian decline in Big Cypress National Preserve. Although no evidence of decline was observed, several threats to amphibians were identified. Introduced species, especially the Cuban treefrog (*Osteopilus septentrionalis*), are predators and competitors with several native frog species. The recreational use of off-road vehicles has the potential to affect some amphibian populations, and a study on those potential impacts is currently underway. Also, interference by humans with the natural hydrologic cycle of south Florida has the potential to alter the amphibian community.

Continued monitoring of the amphibian species in Big Cypress National Preserve is recommended. The methods used in this study were adequate to produce reliable estimates of the proportion of sites occupied by most anuran species, and are a cost-effective means of determining the status of their populations.

Introduction

Declines in amphibian populations have been documented worldwide from many regions and ecosystems (Alford and Richards 1999). No single cause for declines has been demonstrated, and it seems likely that several factors may interact to threaten populations (Carey and Bryant 1995). A major factor in the loss of amphibian populations in the southeastern United States has been and continues to be the loss of habitat (Dodd and Cade 1998). As part of its commitment to stewardship of the natural resources of the national parks, the National Park Service funded an inventory of the amphibians of Big Cypress National Preserve through the NPS Inventory and Monitoring Program. This document describes that inventory project, conducted during 2002 and 2003.

Big Cypress National Preserve (BICY) protects 291,603 ha of natural areas in southwest Florida (Figure 1). BICY consists primarily of shallow seasonal wetland habitats including marshes, sloughs, and cypress forests. In addition, a portion of the park consists of upland habitat; primarily pine forests and tropical hardwood hammocks. These habitats combined make up a heterogeneous matrix of open grasslands and forested wetlands and uplands.

This is the first systematic survey of the herpetofauna of Big Cypress and the only study of this detail to date in southwest Florida. Duellman and Schwartz (1958) produced the first complete species list of the herpetofauna of south Florida. Meshaka et al. (2000) provide a list of species known from collections in adjacent Everglades National Park as of 1999. Rice et al. (2004) provides a detailed systematic survey of Everglades National Park using methods similar to this study. This work combined with a forthcoming report on the herpetofauna of Biscayne

National Park (Rice et al. in prep.) will provide a complete survey of the amphibian species of the National Parks of south Florida.

In addition to providing a sample of georeferenced locations of all amphibian species in BICY, we also estimated the site occupancy rate of each species by habitat. The occupancy rate is estimated based on detection/non-detection data from repeated sampling at randomly chosen sites throughout the park using a model developed by MacKenzie et al. (2002). This method can serve as an index of abundance, and it can be compared to future samples to determine trends in the status of amphibian populations. Encounters with reptiles were not common enough to provide sufficient data for site occupancy modeling, but location data on reptiles is included in this report.

Methods

We sampled for amphibians using several different methods at sites throughout Big Cypress National Preserve in an attempt to identify populations of all amphibian species. In addition to standard sampling methods outlined below, opportunistic encounters with amphibians and reptiles were noted with details on the exact location of the capture and data on each individual animal.

Site Selection

Sampling sites were chosen randomly throughout BICY using a geographic information system (GIS), and all of our sampling was stratified by major habitat type. We divided BICY into five natural habitats: cypress, cypress prairie, prairie, hammock, and pineland (Figure 2). We created these habitat designations by condensing the vegetation classification scheme

proposed by Madden et al. (1999) into our five broader habitat categories. An additional category, disturbed area, was also created, but no sampling took place in disturbed habitat.

We used ArcView 3.2 with the Animal Movement Analysis extension (Hooge and Eichenlaub 1997) to select points at random within each major natural habitat type. We created more random points than could be sampled, so points were selected rom the list of available points for sampling based on availability of access. Many parts of BICY were inaccessible by the means available to us (e.g. airboat, all-terrain vehicle, 4-WD vehicle, foot). Access was also seasonably variable. Areas accessible by airboat during the wet season were not always accessible during the dry season. We sampled every habitat in BICY for at least 12 consecutive months during the period between February 2002 and August 2003.

In total we visited 104 sites at least twice (Figure 3). The highest number of study sites (32) was in prairie habitat, and we visited between 12 and 25 sites in each of the other habitats (Table 1). The number of sampling occasions per site was variable. Some were sampled on a monthly basis during 2002-2003, and many were sampled no more than twice during the entire project. We used repeated sampling at a subset of the more accessible sites as an efficient way to estimate habitat level occupancy rates, while less frequent sampling at more remote locations provided better data on species distribution within the park. Our analysis includes a total of 545 site visits to the 104 sites (Table 1). At least six sites in each habitat were sampled monthly between March 2002 and February 2003 when access was possible (Figure 4).

<u>Visual Encounter Surveys</u>

Our primary method of sampling was a standard visual encounter survey (VES; Heyer et al. 1994) conducted for 30 minutes at the randomly chosen sites. All of our VES samples were begun at least 30 minutes after sunset because preliminary surveys in Everglades National Park indicated that amphibians were more active and therefore more easily detected at night. Each VES was conducted by at least two experienced observers using powerful 6-volt lights with halogen bulbs.

Our VES samples were all within a 20-m radius circle of the randomly chosen point, an area of 1256 m^2. We thoroughly searched as much of each circular plot as was possible in the time allotted, but judgment of the observers was used to determine which areas within the plot got the most emphasis. The goal was to find as many individual amphibians as possible. All possible amphibian locations could be searched including trees and other vegetation as well as bare ground and leaf litter.

We attempted to capture each individual amphibian and reptile that was observed during a VES. The animals were identified to species and sex if possible, and the age/life stage (i.e. juvenile, adult, larva, etc.) was recorded. The snout-to-vent length (SVL) of each animal captured was measured in mm, and the substrate on which each individual was first observed and the perch height (estimated to the nearest 10 cm) was noted.

In addition to the biological data collected during a VES, we also collected some key environmental data in the field at the time of the survey. We measured the air temperature and relative humidity using a digital thermohygrometer. We recorded whether the plot was inundated with water, and if it was, the water temperature was measured and recorded. We also

noted the weather and classified it into one of five categories: clear, partly cloudy, cloudy, rain, or fog. Wind speed was classified as none, light, moderate, or strong. The date and time of the sample and the observers present was also recorded. All data were recorded on personal digital assistants (PDAs) and later transferred to a Microsoft Access database (Waddle et al. 2003).

Anuran Vocalization Surveys

At each random point when a VES was conducted, we also noted all of the species of frogs and toads that were heard vocalizing. The vocalization survey was a 10-minute period during the VES. All anurans that could be heard were included, even if it was possible or likely that they were calling from a location outside of the 20 m radius plot. Including all individuals heard eliminated the need to locate vocalizing individuals, and it facilitates comparison with similar surveys conducted elsewhere or in future studies in BICY.

The abundance of vocalizing individuals was estimated as one of five categories: one individual, 2-5 individuals, 6-10 individuals, >10 individuals, or large chorus. In addition, the frequency of calling by each species was categorized as occasional, frequent, or continuous. These categories were discussed with newer observers in the field so that a consensus could be reached on which category to place the abundance and frequency of calls.

Additional Sampling

We also used several other techniques in addition to the random sampling described above to attempt to fully document the amphibian fauna of BICY. Most of this sampling was done to either augment the species list or as part of other research projects. Data from this

additional sampling is only included in the list of species detected and their locations. Because sites were not randomly chosen and sampling effort was not consistent, these data are not compatible with the proportion of sites occupied analysis technique used for the VES and vocalization surveys (see Data Analysis below).

Drift fences were used in a pilot study to examine the effects of off-road vehicle (ORV) use on the herpetofauna of the prairies of BICY ([Figure 5](#)). These traps were primarily used to target aquatic salamanders, a group that was rarely observed during VES surveys. Traps were placed along side drift fences in open prairie habitat and sampled during the wet season of 2002. One species of amphibian, *Pseudobranchus axanthus belli*, was only detected by this method. Many species of reptiles were only detected opportunistically as we traveled on roads or through the Preserve on our way to and from research sites. These locations were recorded with GPS coordinates for inclusion into a geo-referenced database.

Data Analysis

Detection probabilities for all amphibian and reptile species were assumed *a priori* to be less than one. Therefore, data were collected in a method compatible with the site occupancy model of MacKenzie et al. (2002). Rather than assuming that a species is detected at every site in which it occurs, we estimate the true proportion of sites occupied. This estimate is always greater than or equal to the naive or minimum known occupancy (total number of sites at which the species was detected at least once). This method estimates sampling occasion specific detection probabilities for each species using maximum likelihood statistical techniques. By estimating detection probabilities, we were able to estimate the true site occupancy rate of each

species by habitat, while taking into account the effects of environmental variables on the behavior of the animals. We do not need to assume that detection rates are constant across species, habitats, time, or environment. We do assume, however, that if a species is present, it has a detection probability greater than 0. We also assume that sites are closed to changes in occupancy between subsequent samples, and we therefore only consider data from surveys that were conducted within six months of one another.

All data were compiled in Microsoft Access and then extracted as capture histories for analysis in program PRESENCE (MacKenzie et al. 2003). Our site-specific covariables, those that directly affect the estimate of occupancy (*psi*) were major habitat type and a broader habitat category (Forested or Grassland). Variables that affect detection probability (*p*) were sampling occasion covariables: air temperature, relative humidity, presence of standing water, and season of the year. For each species, we considered twenty-seven models that were combinations of these variables that we determined to be biologically meaningful *a priori* (Table 2). The best model was chosen as the one with the lowest value for Akaike's information criterion (AIC), or the most parsimonious model (model with the best fit for the fewest parameters; Burnham and Anderson 1998). Model selection in this manner allows us to determine the factors that are the most important in sampling for individual species, and determines the best estimate of the site occupancy of each species. We used the best model that included the six habitats as a factor to estimate the habitat-specific occupancy rates of each species using the logit of the coefficient for each habitat from the model (MacKenzie et al. 2002).

Results

During this project we encountered 2358 amphibians and 374 reptiles during VES sampling. We also captured an additional 73 amphibians and 111 reptiles in drift fences and by opportunistic encounter. We detected a total of 18 amphibian species and 34 reptile species during this study. We measured the snout-to-vent length of a total of 1904 amphibians (Table 3). This study did not target reptiles, but as some of the species are readily sampled using the same methods as those for amphibians we report the results below.

Anurans

Acris gryllus

The Florida cricket frog (*Acris gryllus dorsalis*) is widespread throughout BICY. These frogs were detected in every habitat within the park using vocal survey (Table 4; Figure 6), and the species was heard on 168 of 545 sampling occasions. Cricket frogs were detected continuously by vocal survey between March and October in both 2002 and 2003. While breeding may occur year round in this species, our results suggest that vocal survey would be most effective during these months.

During VES, 35 cricket frogs were captured within BICY. They were found in every habitat except for hammock. These occurrences were concentrated between June and August; however, they were also detected in March, October, and December (Table 18). Because of the small size of this species and the abbreviated period during which detection by visual methods was possible, vocalization may be the most effective method for surveying this species. Snout-vent lengths (SVL) were taken from 20 cricket frogs within BICY. SVL measurements for this

species ranged from 16-28 mm with a mean of 22.95 mm (+/- 0.63 SD) (Table 3). Mean SVL

varied from 21.6 to 24.4 mm by habitat (Table 32).

The naïve or minimum site occupancy for the species was 76.92% overall, with values

ranging from 66.67% to 88.24% among different habitats (Table 44).   Using PAO modeling, we

estimated that cricket frogs actually occur in 96.8% (S.E. =0.0211) of all sites within BICY. The

best model (model weight 0.6802) for site occupancy estimation included the two-habitat

category (forested vs. non-forested), the presence/absence of water, and season as covariates. A

model that assumed constant occupancy across habitat types but with the same sampling

covariates had a weight of 0.3198. This suggests that detection of cricket frogs is probably

seasonal and somewhat dependent on the presence of water, while occupancy may or may not

depend on habitat type. Cricket frogs are primarily aquatic, so it is very reasonable that the

presence of standing water would influence their detection. Using the best model that included

all five habitat types, the estimate of site occupancy for each habitat was computed, and results

ranged from 86% to 100% among the habitats (Table 44).

Bufo marinus

The Marine or Cane toad (*Bufo marinus*) was introduced into south Florida in the 1960's

as both a control for agricultural pests and as a pet (Duellman and Schwartz 1958). We were the

first to detect this species in Everglades National Park, and based on these results it appears to be

increasing its range in southern Florida (Rice et al. 2004). Vocalizations were heard at several

sites during this inventory, but no individuals were captured within plots during VES surveys.

Marine toads were heard calling in prairie and pineland habitats within BICY (Table 5; Figure 7)

on 5 of 545 visits. Marine toad vocalizations were heard in the winter months of December and

January and again heard in the summer months of June through August (Table 19), suggesting

that this species may be active year round in south Florida. This fact that no marine toads were

found during VES surveys and relatively few were detected by vocal surveys may indicate that

this species has only recently begun to invade BICY.

Bufo quercicus

The oak toad (*Bufo quercicus*), a small diurnal bufonid, was detected in every habitat in

BICY; however, it was only heard during 17 of 545 visits. Only two individuals were found

during VES, one in prairie and one in pineland habitat (Table 6; Figure 8). *B. quercicus* was

detected by vocalization during the months of January, March, May and June and was detected

by VES in July and October (Table 20). The low number of oak toads detected by this survey is

probably not reflective of their true distribution and abundance. *Bufo quercicus*, unlike other

toads in the park, is chiefly active during the day. Therefore, the design of this study (sampling at

night) was less appropriate for this particular species. Snout-vent length was measured from the

two individual oak toads collected during this study (Table 3; Table 33).

The naïve or minimum site occupancy for the species was 14.42% overall, with values

ranging from 5.56% to 20.00% among different habitats (Table 45). We estimate, based on PAO

modeling, that *B. quercicus* occupied 65.22% (S.E. =0.2776) of all sites within BICY. The best

model (model weight =0.5087 for site occupancy estimation included the two-category habitat

designation, the presence of water, and the four seasons as covariates. A similar model, but with

occupancy constant across habitat types had a high weight (model weight =0.4623) as well.

These results suggest that while habitat may or may not be useful for predicting occupancy, season and the presence of standing water are probably important factors affecting detection probability of oak toads. Taking the best model that included all five habitat types, we computed the estimate of site occupancy for each habitat, results ranged from 23 to 90% among the habitats (Table 45).

Bufo terrestris

Another toad within BICY, the southern toad (*Bufo terrestris*), was detectable using our methods. Southern toads were heard calling in all habitats within BICY on 26 of 545 sampling occasions (Table 7). Vocalizations were heard from March through September and again in December (Table 21). This corresponds with the known breeding pattern for this species, which may occur from March to October depending on rainfall and weather conditions (Conant and Collins 1991).

Southern toads were found visually in cypress, hammock, and pineland habitats (Table 7; Figure 9). Twenty specimens were found during VES, and these specimens were found in March, April, and May (Table 21). Mean SVL of *Bufo terrestris* within EVER was 65.1 mm (+/- 5.5 SD) with a range of 20 to 97 mm (Table 3). Due to the low number of individuals captured during this study, we were unable to determine if significant differences existed between mean SVL of southern toads in different habitats (Table 34).

The naïve or minimum site occupancy for the species was 21.15% overall, with values ranging from 11.76% to 32.00% among different habitats (Table 46), but we estimate the occupancy rate of *B. terrestris* to be 90.16% (S.E. =0.1271) overall within BICY. The best

model for site occupancy estimation (model weight =0.976) included the two-category habitat

classification (forested / non-forested) and season. No other model had significant weight.

Using the best model including all five habitats, we computed the estimate of site occupancy for

each habitat. Results ranged from 45 to 100% among the habitats (Table 46).

Eleutherodactylus planirostris

       Possibly the most widespread of the three established exotic anurans in south Florida, the

Greenhouse frog (*Eleutherodactylus planirostris planirostris*) was detected throughout BICY

(Figure 10). Greenhouse frogs were heard vocalizing on 132 of 545 visits in BICY (Table 8).

Vocalizations were heard from March through November (Table 22). During VES, 39

greenhouse frogs were found in BICY, in all habitat types (Table 8). These frogs were found

during every month except January (Table 22), which suggests that they are active year round in

south Florida. Based on the data collected during this study, it seems that either visual or vocal

surveys are viable methods for monitoring greenhouse frogs. Snout vent lengths of greenhouse

frogs ranged from 14-25 mm with a mean of 19.5 mm (+/- 0.86SD) (Table 3).   We were unable

to determine if significant differences existed in mean size of greenhouse frogs by habitat (Table

35).

       The naïve or minimum site occupancy for the species was 50.0% overall, with values

ranging from 21.88% to 83.33% among different habitats (Table 47). We estimate that *E. p.*

planirostris actually occupies 83.02% (S.E. =0.0684) of all sites within BICY. The best model

(model weight =0.6069) for site occupancy estimation included the two-category habitat

parameter the presence of standing water, and season as covariates. A model with constant site

occupancy across habitats but with the same sampling covariables had a weight of 0.3784.

These models indicate that the general habitat type may be important for site occupancy of

greenhouse frogs, and the presence of water and the time of year are important components of

detection for this species. We computed the estimate of site occupancy for each habitat using the

best model that included all habitat categories. Results ranged from 66 to 100% among the

habitats (Table 47).

Gastrophryne carolinensis

Eastern narrowmouth toads (*Gastrophryne carolinensis*) were heard on 16 of 545 vocal

surveys within BICY (Figure 11). Vocalizations were heard in March, June through August, and

again in November (Table 23). Narrowmouth toads are explosive breeders, with short breeding

periods concurrent with warm seasonal rains (Connant and Collins 1991). These frogs were

heard in every habitat within the park, except prairie. Visual surveys located eight individual

narrowmouth toads, in cypress, hammock, and pineland habitats (Table 9). *Gastrophryne*

carolinensis were found by VES from March through May, suggesting that this may be the time

period during which visual survey is most effective. Snout vent lengths of narrowmouth toads

ranged from 15-26 mm with a mean of 22.2 mm (+/- 2.08SD) (Table 3). No inferences could be

made about differences in SVL by habitat for this species (Table 36).

The naïve or minimum site occupancy for the species was 20.19% overall, with values

ranging from 6.25% to 36.00% among different habitats (Table 48). We estimate that *G.*

carolinensis actually occupied 62.81% (S.E. =0.2425) of sites overall within BICY. The best

model (model weight =0.8950) for site occupancy estimation included the forested vs.

nonforested habitat category as a site covariate and season as a sampling covariate. Little weight was given to a model with constant occupancy across habitat types and season. These results indicate that season is important in detection of narrowmouth toads and major habitat structure is probably important in determining occupancy. The best model that included all five habitats provided an estimate of site occupancy by habitat that ranged from 36 to 100% (Table 48).

Hyla cinerea

The green treefrog (*Hyla cinerea*) was a commonly observed amphibian species during our sampling in BICY. This species was detected in every habitat in the park using either VES or vocalization methods (Table 10; Figure 12). *Hyla cinerea* appears to be a habitat generalist in BICY. We captured 797 individual *H. cinerea* during VES surveys, and we heard at least one *H. cinerea* vocalizing during 119 of our 545 samples.

We detected *H. cinerea* during every month of our sampling (Table 24). *H. cinerea* was captured during VES surveys in every month, and detected through vocalizations from March through October and again in December. This suggests that *H. cinerea* remains active throughout the year and may always be detectable using VES techniques. Morphometric data were collected from 684 *H. cinerea* captured during VES. The overall mean SVL of green treefrogs in BICY was 31.07 mm (+/- 0.31 SD) and a range from 14 to 58 mm (Table 3; Table 37).

The naïve or minimum site occupancy for the species was 87.50% overall, with values ranging from 65.63% to 100.00% among different habitats (Table 49). We estimate that *H. cinerea* actually occupies 98.68% (S.E. =0.0313) of all sites within BICY. The best model

(model weight =0.4487) for site occupancy estimation included the forested vs. non-forested habitat designation and temperature, humidity, and the presence/absence of water as covariates. A model including all of the same covariables except humidity had a high weight as well (0.3324). Habitat structure is probably an important factor for site occupancy of green treefrogs, and detection appears to be dependent on temperature, the presence of water, and sometimes humidity. Taking the best model using the five habitat categories, we computed the estimate of site occupancy for each habitat. Results ranged from 82 to 100% among the habitats (Table 49).

Hyla gratiosa

The barking treefrog (*Hyla gratiosa*) appears to be at the southern edge of its range in BICY. This species was only detected during standard sampling using the vocalization technique, and was not observed within VES plots (Figure 13). We heard at least one *H. gratiosa* vocalizing during 3 of our 545 samples, in hammock and pineland habitats (Table 11), and all vocalizations heard were during the month of August (Table 25). The individuals that were observed were found at breeding sites. It appears that this species is breeding within the preserve, but probably occurs in very low density.

Hyla squirella

The squirrel treefrog (*Hyla squirella*) was the most commonly observed amphibian in BICY. *H. squirella* was detected by VES and by vocalization in every habitat (Figure 14). *Hyla squirella* is a habitat generalist, and appears to be ubiquitous in BICY. A total of 1144 *H. squirella* were found using VES, and the species was heard during 60 of 545 samples (Table 12).

H. squirella was detected by VES during all months of the survey. Detection of *H. squirella* by vocalization occurred from March through August (Table 26). The absence of this species from several months of vocal survey suggests that VES may be a more effective survey method for *H. squirella*. SVL Measurements were taken from 1009 individual *H. squirella* captured by VES across the five habitats (Table 38). The mean SVL for squirrel treefrogs in BICY was 20.93 mm (+/-0.14 SD), which is slightly lower than the published size range for this species (Table 3).

The naïve or minimum site occupancy for *H. squirella* was 66.35% overall, with values ranging from 37.50% to 92.00% among different habitats (Table 50). Using site occupancy modeling, we estimated that *H. squirella* occupied 79.98% (S.E. =0.0522) of all sites within BICY. The best model for site occupancy estimation (model weight =0.4455) included the two-category habitat designation as a site covariate and air temperature and presence/absence of water as sampling covariates. A model including the two habitats and season and presence of water produced a similar AIC value with a model weight of 0.3654. These models suggest that habitat structure is probably an important influence on occupancy, and water is important for detection. Using the best model that included all five habitats, the estimate of site occupancy for each habitat ranged from 51 to 100% among the habitats (Table 50).

Osteopilus septentrionalis

The Cuban treefrog (*Osteopilus septentrionalis*) is an exotic hylid species primarily found in disturbed areas of BICY (Figure 15). We detected *O. septentrionalis* during vocal surveys in every habitat type except cypress (Table 13). Twelve individuals of *O. septentrionalis*

were captured during VES and at least one vocalization was heard during 5 of the 545 sampling occasions. The overall mean SVL of Cuban treefrogs captured during this study was 61.2 mm (+/- 5.70 SD) (Table 3; Table 39).

O. septentrionalis was detected by VES in all months of sampling except March, April, August, and September. This indicates that *O. septentrionalis* is active throughout the year and may always be detectable using visual techniques. *O. septentrionalis* was detected by vocal survey during April, and again in July through September (Table 27).

The naïve or minimum site occupancy for the species was 5.77% overall, with values ranging from 0.00% to 16.67% among different habitats (Table 51). We estimate that *O. septentrionalis* actually occupied 13.05% (S.E. =0.0513) of all sites within BICY, which is much lower than the 34.66% overall PAO estimate for Cuban treefrogs form Everglades National Park. The best model for site occupancy estimation (model weight =0.5357) assumed constant occupancy across habitats and included the presence of water as a sampling covariate. A model with constant occupancy and detection had a low delta AIC (model weight =0.1770) and may also be reasonable. These models indicate that the habitat and detection covariables do not adequately explain the distribution of Cuban treefrogs. This species has only recently invaded BICY and is still primarily found near roads, buildings, and other disturbed areas. The best model that included all five habitats produced an estimate of site occupancy for each habitat that ranged from 0 to 29.7% among the habitats (Table 51).

Pseudacris nigrita

The southern chorus frog (*Pseudacris nigrita*) was a relatively rare hylid species within the preserve. *P. nigrita* was found in cypress and cypress prairie habitat during VES survey. Vocal surveys detected southern chorus frogs in all habitat types in BICY (Figure 16). Only 5 individuals of this species were captured, and vocalizations were only heard during 25 of our 545 sampling occasions (Table 14). The mean snout-vent length of southern chorus frogs was 25.3 mm (+/- 2.67 SD) (Table 3). There was insufficient data to examine differences in SVL by habitat (Table 40). *P. nigrita* was detected by vocal surveys from March through June and again in December and VES detection of *P. nigrita* was sporadic (Table 28).

The naïve or minimum site occupancy for the species was 17.31% overall, with values ranging from 9.38% to 25.00% among different habitats (Table 52). The overall estimate of true site occupancy is 55.08% (S.E. =0.1281). The best model (model weight =0.5151) for estimation assumed constant occupancy across habitats and used air temperature, relative humidity, and the presence/absence of water as sampling occasion covariates. The next best model (model weight =0.1865) was essentially the same but it excluded relative humidity. These results indicate that either habitat structure is not important to the occupancy of chorus frogs in BICY, or encounter rates were too low to identify real habitat associations. Air temperature and the presence of water are probably important for detection, although since water levels increase during the summer in BICY, the two are probably correlated. The best model that included all five habitats produced habitat-specific occupancy rates between 40 and 69% (Table 52).

Pseudacris occularis

The little grass frog (*Pseudacris occularis*) was detected in every habitat in BICY. Ninety-seven individuals of *P. occularis* were found during VES (Table 15). This species appears to be much more abundant in BICY than in Everglades National Park (Rice et al. 2004). Vocalizations for *P. occularis* were heard in all habitats except hammock (Figure 17) and the species was heard on 54 out of 545 sapling occasions (Table 15). *P. occularis* was encountered using VES during every month of the survey. Vocalization surveys detected *P. occularis* from May thorough September and again in December (Table 29). The mean SVL for *P. occularis* was 13.60 (+/- 0.22 SD) (Table 3; Table 41). Little grass frogs were much more commonly observed in BICY than they were in Everglades National Park (Rice et al. 2004). It is not clear if Everglades represents the extreme edge of their range or if the heterogeneous nature of habitats in Big Cypress creates a more suitable environment for the species.

The naïve or minimum site occupancy for the species was 27.88% overall, with values ranging from 12.50% to 52.00% among different habitats (Table 53). We estimate that little grass frogs actually occur at 48.02% (S.E. =0.0752) of all sites within BICY. The best PAO model (model weight =0.5886) assumed constant occupancy across habitat types and included season and the presence/absence of water as sampling covariables. The second and third best models (model weights =0.1400 and 0.1079, respectively) were ones with the two-category habitat and the same sampling covariables and one with constant occupancy and only season as a sampling covariable, respectively. It appears that habitat is not very important in determining whether little grass frogs will be present in BICY, but time of year probably is important for

detection. The best model that included all five BICY habitats produced habitat specific occupancy estimates of 33.05% to 74.24% (Table 53).

Rana grylio

The pig frog (*Rana grylio*) is common throughout the wetter areas of south Florida. This species was detected in every habitat of BICY using both VES and vocalization techniques (Table 16; Figure 18). A total of 52 individuals of *R. grylio* were captured during VES, and the species was heard vocalizing during 195 of 545 samples. The overall mean SVL of pig frogs within BICY was 64.35 mm (+/- 5.89 SD; Table 3; Table 42). During the study, *R. grylio* was captured in every month during VES and was detected by vocalization in every month (Table 30). This suggests that this species may remain active throughout the year and both survey techniques are efficient at detecting *R. grylio* in BICY. Pig frogs are known to be relatively aquatic, and are seldom found far from water. In BICY, however, the heterogeneous nature of the habitat means that few sites are too far away from water to hear pig frogs vocalize.

The naïve or minimum site occupancy for the species was 80.77% overall, with values ranging from 65.63% to 91.67 among different habitats (Table 54). We estimate that *R. grylio* actually occupied 99.96% (S.E. =0.0267) of all sites within BICY. The best model for site occupancy estimation included the two-category habitat designation and season as a sampling covariate. No other models had any weight. No models with all five habitats were able to converge, so we are unable to produce an estimate of occupancy among habitats for pig frogs (Table 54).

Rana sphenocephala

The southern leopard frog (*Rana sphenocephala*) was also found throughout BICY. This species was encountered using VES and vocalization techniques in every habitat (Table 17; Figure 19). The mean SVL of captured individuals ranged from 28 to 100 mm with a mean of 54.86 mm (+/- 2.32 SD) (Table 3; Table 43). *R. sphenocephala* was encountered every month of our sampling during VES surveys and they were detected during every month except March and May using vocalization surveys (Table 31). One hundred and forty two individuals of *R. sphenocephala* were found during VES surveys, and vocalization by at least one individual was heard during 87 of our 545 samples.

The naïve or minimum site occupancy for the species was 75.96% overall, with values ranging from 64.00% to 84.38% among different habitats (Table 55). Estimates indicate that *R. sphenocephala* actually occupies 98.79% (S.E. =0.240) of all sites within BICY. The best model for site occupancy estimation (model weight =0.5965) assumed constant occupancy across habitats and included temperature and the presence/absence of water as detection covariates. A model with the same sampling covariates, but including the two-category habitat designation also had some support (model weight =0.1284) as did a model including humidity (model weight =0.1245). Using the best model that included all habitat types, the estimate of site occupancy by habitat ranged from 93 to 100% (Table 55).

Caudates

Amphiuma means

The two-toed amphiuma (*Amphiuma means*) was one of the most numerous salamanders found during this study. A total of 8 individuals were captured using various survey techniques (Table 56). Four individuals were observed during VES surveys and four were observed opportunistically. Locations of these captures are shown in Figure 20. Interestingly, no amphiuma were captured during drift fence trapping in prairie habitat. This species is probably more common than the numbers captured in this study suggest. The sampling performed for this study was not ideal for capturing or detecting *Amphiuma*. The majority of the *Amphiuma* captured in Everglades National Park were bycatch in drift fences intended to capture fish (Rice et al. 2004). No PAO analysis was performed for this species due to the low number of captures.

Notophthalmus viridescens

The peninsula newt (*Notophthalmus viridescens piaropicola*), the only member of the family salamandridae found in south Florida, was also present within BICY. A total of 4 individuals were found in the preserve, with the majority being observed opportunistically (Table 56; Figure 21). Only one individual was detected during VES. This species is probably best sampled with minnow traps in flooded habitats. Fish sampling performed by a crew working for the National Audubon Society and the U.S. Geological Survey detected many more newts than this study. The sampling most appropriate for newts is not compatible with sampling for other

amphibians. No PAO analysis was performed for this species, as there were not enough captures for estimation of occupancy rates.

Pseudobranchus axanthus

Only one individual of the Everglades dwarf siren (*Pseudobranchus axanthus belli*), a subspecies endemic to south Florida, was found during this survey. This species was listed as occurring in Everglades National Park (Meshaka et al. 2000), but was not detected during a survey similar to this one in 2001-2002 (Rice et al. 2004). The single individual that was captured came from a drift fence in a short-hydroperiod prairie habitat (Table 56; Figure 22). Unfortunately the specimen was found dead in the trap, but the individual was collected. A frozen tissue sample was given to Paul Moler of the Florida Fish and Wildlife Conservation Commission, who is overseeing a study of the systematics of *Pseudobranchus*.

Siren lacertina

Another member of the family sirenidae, the greater siren (*Siren lacertina*), was detected within the park using our methods. A total of eight greater sirens were found during this study (Table 56). Seven of these individuals were captured in drift fence arrays in short-hydroperiod prairie habitat (Figure 5). One individual was also detected opportunistically during the study (Figure 23). This species is certainly under-represented in this study. Subsequent studies in Big Cypress have detected high local abundances of greater siren. Trapping appears to be the only reliable method for detection of this species, and trapping at every site at which we surveyed was outside the scope of this project. No PAO analysis was conducted on this species as capture

numbers were so low, but this species is the focus of a new project examining the expected

benefits of Everglades restoration activities to the amphibian fauna of south Florida.

Reptiles

The primary focus of this study was to sample amphibian species within Big Cypress, but

many of the methods used were also appropriate for sampling reptiles. We have therefore

collected and summarized the data on reptile species encountered during this study. Meshaka et

al. (2000) listed 57 species of reptiles present in Everglades National Park. Based on this work

and the list provided by Duellman and Schwartz (1958), we believe that there are potentially 58

species of reptiles in natural areas of south Florida (this excludes introduced species known only

from urban areas in Miami-Dade and Broward Counties). Excluding marine species and species

with no known populations in southwest Florida, we believe that there are potentially 46 species

of reptiles in BICY (Table 57). During this study, we encountered 35 of those species (Table

58). Locations of occurrences by species are shown alphabetically within classes: Crocodilians

(Figure 24), Lizards (Figures 25-32), Snakes (Figures 33-51), and Turtles (Figures 52-58).

Introduced Species

Four reptile species found during this study are exotic to south Florida. The brown anole,

Anolis sagrei, was the most abundant exotic reptile found in the park, with 252 individuals being

found during VES alone. Brown anoles were primarily found near disturbed areas within the

park (Figure 26). Two other introduced reptile species, the tropical house gecko (*Hemidactlyus*

mabouia), and the Indo-Pacific gecko (*Hemidactylus garnotii*) were only found on or near

buildings and disturbed areas. Only two house geckos were found during VES surveys, and the

Indo-Pacific gecko was only found opportunistically. The fourth exotic reptile encountered

during this study was the green iguana. One individual of this species was collected from U.S. 41

in the preserve.

Three of the "potential" reptiles that were not observed during this study are introduced.

One, the Burmese python, *Python molorus*, has been seen by BICY staff as recently as March

2004. This species probably occurs in BICY and may even be breeding in the preserve.

Evidence from Everglades National Park suggests that this species is breeding there (Skip Snow,

pers. comm.). The two other potential introduced reptiles in BICY are the Brahminy blind

snake, *Ramphotyphlops braminus*, and the Mediterranean gecko, *Hemidactylus tursicus*. The

blind snake is most often introduced through landscaping material (Connant and Collins 1991).

Since there is little human settlement in BICY, this species may not occur there. The

Mediterranean gecko is likely to occur on buildings in BICY, but was not detected in any natural

areas. This species has spread throughout southern Florida, but is primarily restricted to edifices.

Species of Special Concern

No reptiles of conservation concern were found during this study. There are four known

or thought to occur in BICY, but they were not detected by any of our methods. The gopher

tortoise, *Gopherus polyphemus*, is listed by the state of Florida as a "species of special concern."

Most of the land in Big Cypress is too poorly drained for tortoises, but some areas in the addition

lands may be suitable. Dalrymple (1995) did report discovering some gopher tortoises. The

eastern indigo snake, *Drymarchon corais*, is Federally listed as threatened. We did not find any

indigo snakes during any of our work, but other researchers have located them as recently as December 2004 in the addition lands area. No information on the status of either of these species in BICY is available at this time.

Two other reptiles of conservation concern are the American alligator, *Alligator mississippiensis*, and the American crocodile, *Crocodylus acutus*. The alligator is listed as a "species of special concern" by the state of Florida, and as "threatened due to similarity of appearance" by the U.S. Fish and Wildlife Service. Alligators are widespread throughout the park and 7 individuals were found during our VES ([Figure 24](#)). The American crocodile is listed as "endangered" by both the state of Florida and the U.S. Fish and Wildlife Service. One individual of this species was observed in the canal just north of U.S. 41 on the western border of the preserve after this project was concluded. The crocodile is probably an occasional resident of BICY, but the status of this species in the preserve is unknown.

Unobserved Species

Only three other snake and two other turtle species were not observed during this study. The coral snake, *Micrurus fulvius*, and the mud snake, *Farancia abacura*, are probably present in the preserve, but just went undetected. Coral snakes are small and difficult to detect using our methods. No coral snakes were detected in Everglades National Park in a similar study either (Rice et al. 2004). Mud snakes may be difficult to detect because of their aquatic nature. Only one mud snake was found opportunistically in Everglades National Park (Rice et al. 2004). The third snake that was missed, the mangrove salt marsh snake (*Nerodia clarkii*), may or may not

have suitable habitat in BICY. This species is most often found in estuarine areas. It is possible

that it occurs in the southwestern portion of the Preserve, but we have no evidence of this.

The two turtle species that were not detected in the preserve, the Florida mud turtle

(*Kinosternon subrubrum*) and the common musk turtle (*Sternotherus odoratus*), are both

relatively rare in south Florida compared to the striped mud turtle, *Kinosternon baurii* (Meshaka

et al. 2000; Rice et al. 2004). Both of these species may be present in BICY. They are both

more aquatic than the striped mud turtle, and may therefore be less likely to be detected given

our sampling methods. Their preferred habitat may be borrow pits and canals, a habitat type that

makes up a very small portion of the Preserve and was not sampled during this study.

Discussion

This study represents the first thorough inventory of amphibian species in Big Cypress

National Preserve. Work done by Duellman and Schwartz (1958) across south Florida provides

a bench mark against which current amphibian distributions can be measured, but it lacks

rigorous sampling. Dalyrymple (1995) conducted surveys in the addition lands portion of the

preserve, but no sampling of amphibians was conducted in the other management units. Our

study provides the first complete list of amphibians for all of Big Cypress National Preserve and

it includes the first attempt to estimate the relative abundance of populations of each species.

We believe, however, that the greatest value of this work is as a baseline for comparison in

future monitoring efforts.

One of the goals of this project was to determine if there was evidence of decline in any

of the native species of amphibians. No species of amphibian currently known to be present in

BICY appears to be imperiled due to anthropogenic or unknown factors. This is encouraging given the apparent declines of many amphibian species in protected areas worldwide (Alford and Richards 1999). We detected all of the species of amphibians we anticipated with the exception of one. Some reports suggested that *Hyla femoralis*, the pine woods treefrog, would be present in BICY. We found no proof that the species is present, even after frequent sampling trips to several pineland sites in the northern part of the preserve. It is possible that this species did occur in BICY in the past, but only in small populations at the southern edge of its range. All of the other amphibian species listed from the preserve were detected and evidence of reproduction was apparent for all anuran species.

Although we did not find any evidence of declines among the amphibian species in BICY, we do not believe that this means all the amphibian species are without threats. We have identified several potential threats to the amphibian fauna of BICY. One potential problem is invasive species, especially the Cuban treefrog (*Osteopilus septentrionalis*). This species has reached very high densities in some protected natural areas in Everglades National Park (Rice et al. 2004), and it takes a variety of vertebrate prey (Meshaka 2001, Maskell et al. 2003). The impact to the native treefrog assemblage is under investigation, but it appears that the combination of direct and indirect competition and predation allows Cuban treefrogs to increase to the detriment of native species (Rice et al., in prep.). The giant toad (*Bufo marinus*) is another introduced species that appears to be expanding its range in the park. This species is also a voracious predator, and although it is relatively rare in the natural areas of south Florida now, it may be increasing in abundance and expanding its range.

An important management concern that may pose a threat to some amphibian populations is the use of off-road vehicles (ORV) in the preserve. Preliminary analysis of anuran species distributions in BICY in relation to historic patterns of ORV use suggest that, at a landscape scale, amphibian distribution is influenced by ORV use (J. H. Waddle, unpublished data). This effect is likely beneficial for some species and detrimental to others. We are continuing to conduct research in Big Cypress on the effects of ORV use on amphibians. Hydrologic change due to water management may also impact amphibians. Research to identify the effects of changes in hydropattern and to make predictions about the expected shift in the amphibian community during Everglades restoration is currently underway.

The fact that no amphibian species appears to be declining and that none of the potential threats to amphibians appear to be overwhelming is very encouraging news for managers of BICY. This inventory was designed to serve as a baseline for future monitoring efforts that will ensure that no amphibian species declines will be unnoticed. The data collected during these surveys serve as a snapshot of amphibian species distribution among habitats and across the Preserve in 2002-2003. The PAO technique that was employed in this study provides a robust estimate of the true number of sites occupied given that not all species are perfectly detectable. Surveys conducted in a similar manner in the future will be directly comparable because the issue of detectability is explicitly addressed in the analysis (MacKenzie et al. 2002).

We recommend that follow-up surveys be conducted on a 5-10 year basis. The surveys should use both VES and vocalization techniques in the field, as neither method alone was sufficient for all species. Sites should be chosen randomly throughout the park. Habitat structure (e.g. forested vs. non-forested) was one of the most important covariables in modeling

site occupancy. Sampling should therefore be stratified by at least this two-category habitat. Sampling may be conducted just during the warmer, wetter months for maximum efficiency as very little information was added by including the winters in this study. Estimates of proportion of sites occupied with confidence intervals from future monitoring can be directly compared to the estimates from this study. For example, an increase in *psi* of 0.2 would be interpreted as a 20% increase in the number of sites occupied, or *vice versa*. Although these methods do not allow an estimate of the absolute abundance of amphibians, they do provide a convenient surrogate: the abundance of sites occupied by each species. This number is more easily obtained and comparable across time and among different sampling techniques.

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Tables

Table 1: Number of sampling sites and total number of site visits by habitat.

Habitat	Number of Sites	Number of Visits
Cypress	18	105
Cypress Prairie	17	94
Prairie	32	124
Hammock	12	82
Pineland	25	140
Total	104	545

Table 2: The 27 models chosen for testing with each species in program PRESENCE.

Occupancy Rate Variables	Detection Probability Variables
Constant	Constant
Constant	4 Season, Water
Constant	4 Seasons
Constant	Humid
Constant	Temp
Constant	Temp, 4 season
Constant	Temp, Humid, Water
Constant	Temp, Water
Constant	Water
2 Habitats	Constant
2 Habitats	4 Season, Water
2 Habitats	4 Seasons
2 Habitats	Humid
2 Habitats	Temp
2 Habitats	Temp, 4 season
2 Habitats	Temp, Humid, Water
2 Habitats	Temp, Water
2 Habitats	Water
6 Habitats	Constant
6 Habitats	4 Season, Water
6 Habitats	4 Seasons
6 Habitats	Humid
6 Habitats	Temp
6 Habitats	Temp, 4 season
6 Habitats	Temp, Humid, Water
6 Habitats	Temp, Water
6 Habitats	Water

Table 3: Mean and range of snout-vent length of amphibians measured during visual encounter survey.

Species	Number of Individuals	Mean Snout-Vent Length (+/- SD)	Range of Snout-Vent Length (mm)
Bufo quercicus	2	16.5 (+/- 5.5)	11-22
Bufo terrestris	20	65.1 (+/- 3.27	20-97
Acris gryllus	20	22.95 (+/- 0.63)	16-28
Hyla cinerea	684	31.07 (+/- 0.31)	14-58
Hyla squirella	1009	20.93 (+/- 0.14)	9-39
Osteopilus septentrioinalis	9	61.2 (+/- 5.70)	35-82
Psuedacris nigrita verrucosa	3	25.3 (+/- 2.67)	20-28
Psuedacris occularis	57	13.60 (+/- 0.22)	10-17
Eleutherodactylus planirostris	15	19.5 (+/- 0.86)	14-25
Gastrphryne carolinensis	5	22.2 (+/- 2.08)	15-26
Rana grylio	20	64.35 (+/- 5.89)	35-114
Rana sphenocephala	59	54.86 (+/- 2.32)	28-100
Notopthalmus viridscens priapicola	1	42 (+/- 0)	42-42

Table 4: Number of individual *Acris gryllus* captured and number of site visits during which at least one *A. gryllus* was heard vocalizing by habitat

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	11	33	105
Cypress Prairie	7	39	94
Hammock	0	40	82
Prairie	3	10	124
Pineland	14	46	140
Total	35	168	545

Table 5: Number of individual *Bufo marinus* captured and number of site visits during which at least one *B. marinus* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	0	0	105
Cypress Prairie	0	0	94
Hammock	0	0	82
Prairie	0	4	124
Pineland	0	1	140
Total	0	5	545

Table 6: Number of individual *Bufo quercicus* captured and number of site visits during which at least one *B. quercicus* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	0	2	105
Cypress Prairie	0	3	94
Hammock	0	4	82
Prairie	1	1	124
Pineland	1	7	140
Total	2	17	545

Table 7: Number of individual *Bufo terrestris* captured and number of site visits during which at least one *B. terrestris* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	1	3	105
Cypress Prairie	0	4	94
Hammock	1	7	82
Prairie	0	3	124
Pineland	18	9	140
Total	20	26	545

Table 8: Number of individual *Eleuthrodactylus planirostris* captured and number of site visits during which at least one *E. planirostris* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	4	18	105
Cypress Prairie	2	21	94
Hammock	26	22	82
Prairie	3	36	124
Pineland	4	35	140
Total	39	132	545

Table 9: Number of individual *Gastrophryne carolinensis* captured and number of site visits during which at least one *G. carolinensis* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	2	3	105
Cypress Prairie	0	3	94
Hammock	4	2	82
Prairie	0	0	124
Pineland	2	8	140
Total	8	16	545

Table 10: Number of individual *Hyla cinerea* captured and number of site visits during which at least one *H. cinerea* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	116	23	105
Cypress Prairie	150	25	94
Hammock	125	18	82
Prairie	251	20	124
Pineland	155	33	140
Total	797	119	545

Table 11: Number of individual *Hyla gratiosa* captured and number of site visits during which at least one *H. gratiosa* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	0	0	105
Cypress Prairie	0	0	94
Hammock	0	1	82
Prairie	0	0	124
Pineland	0	2	140
Total	0	3	545

Table 12: Number of individual *Hyla squirella* captured and number of site visits during which at least one *H. squirella* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	213	8	105
Cypress Prairie	93	10	94
Hammock	164	9	82
Prairie	125	14	124
Pineland	549	19	140
Total	1144	60	545

Table 13: Number of individual Osteopilus septentrionalis captured and number of site visits during which at least one O. septentrionalis was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	0	0	105
Cypress Prairie	0	1	94
Hammock	12	2	82
Prairie	0	1	124
Pineland	0	1	140
Total	12	5	545

Table 14: Number of individual *Pseudacris nigrita* captured and number of site visits during which at least one *P. nigrita* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	2	3	105
Cypress Prairie	3	3	94
Hammock	0	6	82
Prairie	0	3	124
Pineland	0	10	140
Total	5	25	545

Table 15: Number of individual *Pseudacris occularis* captured and number of site visits during which at least one *P. occularis* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	10	3	105
Cypress Prairie	13	5	94
Hammock	12	0	82
Prairie	37	15	124
Pineland	25	31	140
Total	97	54	545

Table 16: Number of individual *Rana grylio* captured and number of site visits during which at least one *R. grylio* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	5	39	105
Cypress Prairie	10	40	94
Hammock	20	43	82
Prairie	5	28	124
Pineland	12	45	140
Total	52	195	545

Table 17: Number of individual *Rana sphenocephala* captured and number of site visits during which at least one *R. sphenocephala* was heard vocalizing by habitat.

Habitat	Individual Captures	Visits with Vocalizations Detected	Number of Visits
Cypress	36	16	105
Cypress Prairie	25	8	94
Hammock	31	40	82
Prairie	15	5	124
Pineland	35	18	140
Total	142	87	545

Table 18: Months in 2002-2003 during which *Acris gryllus* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		X
Feb		
Mar	X	X
Apr		X
May		X
Jun	X	X
Jul	X	X
Aug	X	X
Sep		X
Oct	X	X
Nov		
Dec	X	X

Table 19: Months in 2002-2003 during which *Bufo marinus* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		X
Feb		
Mar		
Apr		
May		
Jun		X
Jul		X
Aug		X
Sep		
Oct		
Nov		
Dec		X

Table 20: Months in 2002-2003 during which *Bufo quercicus* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		X
Feb		
Mar		X
Apr		
May		X
Jun		X
Jul	X	
Aug		
Sep		
Oct	X	
Nov		
Dec		

Table 21: Months in 2002-2003 during which *Bufo terrestris* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		
Feb		
Mar	X	X
Apr	X	X
May	X	X
Jun		X
Jul		X
Aug		X
Sep		X
Oct		
Nov		
Dec		X

Table 22: Months in 2002-2003 during which *Eleuthrodactylus planirostris* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		
Feb	X	
Mar	X	X
Apr	X	X
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	X
Nov	X	X
Dec	X	

Table 23: Months in 2002-2003 during which *Gastrophryne carolinensis* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		
Feb		
Mar	X	X
Apr	X	
May	X	
Jun		X
Jul		X
Aug		X
Sep		
Oct		
Nov		X
Dec		

Table 24: Months in 2002-2003 during which *Hyla cinerea* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	
Feb	X	
Mar	X	X
Apr	X	X
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	X
Nov	X	
Dec	X	X

Table 25: Months in 2002-2003 during which *Hyla gratiosa* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		
Feb		
Mar		
Apr		
May		
Jun		
Jul		
Aug		X
Sep		
Oct		
Nov		
Dec		

Table 26: Months in 2002-2003 during which *Hyla squirella* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	
Feb	X	
Mar	X	X
Apr	X	X
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	
Oct	X	
Nov	X	
Dec	X	

Table 27: Months in 2002-2003 during which *Osteopilus septentrionalis* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	
Feb	X	
Mar		
Apr		X
May	X	
Jun	X	
Jul	X	X
Aug		X
Sep		X
Oct	X	
Nov	X	
Dec	X	

Table 28: Months in 2002-2003 during which *Pseudacris nigrita* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan		
Feb		
Mar	X	X
Apr		X
May		X
Jun	X	X
Jul		
Aug		
Sep	X	
Oct		
Nov		
Dec	X	X

Table 29: Months in 2002-2003 during which *Pseudacris occularis* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	
Feb	X	
Mar	X	
Apr	X	
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	
Nov	X	
Dec	X	X

Table 30: Months in 2002-2003 during which *Rana grylio* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	X
Feb	X	X
Mar	X	X
Apr	X	X
May	X	X
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	X
Nov	X	X
Dec	X	X

Table 31: Months in 2002-2003 during which *Rana sphenocephala* was detected by VES methods and vocalization.

Month	VES	Vocalization
Jan	X	X
Feb	X	X
Mar	X	
Apr	X	X
May	X	
Jun	X	X
Jul	X	X
Aug	X	X
Sep	X	X
Oct	X	X
Nov	X	X
Dec	X	X

Table 32: Average snout-vent length for *Acris gryllus* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	5	21.6	0.93
Cypress Prairie	5	24.4	1.12
Hammock	0	N/A	N/A
Prairie	0	N/A	N/A
Pineland	10	22.9	1

Table 33: Average snout-vent length for *Bufo quercicus* (found using VES) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	0	N/A	N/A
Cypress Prairie	0	N/A	N/A
Hammock	0	N/A	N/A
Prairie	1	11	0
Pineland	1	22	0

Table 34: Average snout-vent length for *Bufo terrestris* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	0	58	0
Cypress Prairie	0	N/A	N/A
Hammock	1	20	0
Prairie	0	N/A	N/A
Pineland	10	57.2	4.15

Table 35: Average snout-vent length for *Eleuthrodactylus planirostris* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	2	22	1
Cypress Prairie	1	15	0
Hammock	9	18.89	1.12
Prairie	1	23	0
Pineland	2	20.5	2.5

Table 36: Average snout-vent length for Gastrophryne carolinensis (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	2	25	0
Cypress Prairie	0	N/A	N/A
Hammock	2	20.5	5.5
Prairie	0	N/A	N/A
Pineland	1	20	0

Table 37: Average snout-vent length for *Hyla cinerea* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	97	31.09	0.89
Cypress Prairie	126	33.17	0.66
Hammock	111	35.10	0.82
Prairie	212	27.95	0.40
Pineland	138	30.70	0.79

Table 38: Average snout-vent length for *Hyla squirella* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	195	21.68	0.32
Cypress Prairie	86	22.06	0.43
Hammock	152	23.26	0.34
Prairie	114	20.25	0.40
Pineland	462	19.81	0.21

Table 39: Average snout-vent length for *Osteopilus septentrionalis* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	0	N/A	N/A
Cypress Prairie	0	N/A	N/A
Hammock	9	61.20	5.69
Prairie	0	N/A	N/A
Pineland	0	N/A	N/A

Table 40: Average snout-vent length for *Pseudacris nigrita* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	1	20	0
Cypress Prairie	2	28	0
Hammock	0	N/A	N/A
Prairie	0	N/A	N/A
Pineland	0	N/A	N/A

Table 41: Average snout-vent length for *Pseudacris occularis* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	4	13.25	0.85
Cypress Prairie	8	14.13	0.35
Hammock	10	13.90	0.41
Prairie	22	13.18	0.40
Pineland	13	13.85	0.49

Table 42: Average snout-vent length for *Rana grylio* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	1	35	0
Cypress Prairie	4	77.75	12.43
Hammock	8	59.88	9.26
Prairie	0	N/A	N/A
Pineland	7	66	10.67

Table 43: Average snout-vent length for *Rana sphenocephala* (found using VES and opportunistic encounter surveys) stratified by habitat.

Habitat	Individuals Measured (N)	Mean Snout-Vent Length (mm)	Standard Deviation
Cypress	16	52.69	4.07
Cypress Prairie	8	62.50	6.94
Hammock	10	50.40	5.32
Marsh	5	65.20	9.83
Pineland	20	53.20	3.96

Table 44: Number of sites sampled, sites at which *Acris gryllus* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	15	83.33%	100.00%
Cypress Prairie	17	15	88.24%	100.00%
Hammock	12	8	66.67%	86.31%
Prairie	32	22	68.75%	95.24%
Pineland	25	20	80.00%	100.00%
Total	104	80	76.92%	96.80%

Table 45: Number of sites sampled, sites at which *Bufo quercicus* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	1	5.56%	23.32%
Cypress Prairie	17	3	17.65%	81.18%
Hammock	12	1	8.33%	25.23%
Prairie	32	5	15.63%	74.85%
Pineland	25	5	20.00%	90.41%
Total	104	15	14.42%	65.22%

Table 46: Number of sites sampled, sites at which *Bufo terrestris* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	4	22.22%	68.41%
Cypress Prairie	17	2	11.76%	45.39%
Hammock	12	3	25.00%	80.26%
Prairie	32	5	15.63%	100.00%
Pineland	25	8	32.00%	91.83%
Total	104	22	21.15%	90.16%

Table 47: Number of sites sampled, sites at which *Eleuthrodactylus planirostris* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	10	55.56%	81.20%
Cypress Prairie	17	8	47.06%	77.20%
Hammock	12	10	83.33%	100.00%
Prairie	32	7	21.88%	89.66%
Pineland	25	17	68.00%	66.50%
Total	104	52	50.00%	83.02%

Table 48: Number of sites sampled, sites at which *Gastrophryne carolinensis* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	5	27.78%	76.92%
Cypress Prairie	17	2	11.76%	37.25%
Hammock	12	3	25.00%	78.18%
Prairie	32	2	6.25%	100.00%
Pineland	25	9	36.00%	36.00%
Total	104	21	20.19%	62.81%

Table 49: Number of sites sampled, sites at which *Hyla cinerea* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	18	100.00%	100.00%
Cypress Prairie	17	17	100.00%	100.00%
Hammock	12	12	100.00%	100.00%
Prairie	32	21	65.63%	100.00%
Pineland	25	23	92.00%	82.55%
Total	104	91	87.50%	98.68%

Table 50: Number of sites sampled, sites at which *Hyla squirella* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	13	72.22%	82.30%
Cypress Prairie	17	10	58.82%	70.19%
Hammock	12	11	91.67%	100.00%
Marsh	32	12	37.50%	100.00%
Pineland	25	23	92.00%	51.49%
Total	104	69	66.35%	79.98%

Table 51: Number of sites sampled, sites at which *Osteopilus septentrionalis* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	0	0.00%	0.00%
Cypress Prairie	17	1	5.88%	10.05%
Hammock	12	2	16.67%	29.65%
Prairie	32	2	6.25%	16.59%
Pineland	25	1	4.00%	13.27%
Total	104	6	5.77%	13.05%

Table 52: Number of sites sampled, sites at which *Pseudacris nigrita* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	4	22.22%	58.21%
Cypress Prairie	17	3	17.65%	67.86%
Hammock	12	3	25.00%	69.98%
Prairie	32	3	9.38%	58.02%
Pineland	25	5	20.00%	40.10%
Total	104	18	17.31%	55.08%

Table 53: Number of sites sampled, sites at which *Pseudacris ocularis* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	4	22.22%	35.70%
Cypress Prairie	17	5	29.41%	55.18%
Hammock	12	3	25.00%	31.19%
Prairie	32	4	12.50%	40.59%
Pineland	25	13	52.00%	81.68%
Total	104	29	27.88%	48.02%

Table 54: Number of sites sampled, sites at which *Rana grylio* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat. No habitat specific occupancy model converged.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	16	88.89%	NA
Cypress Prairie	17	15	88.24%	NA
Hammock	12	11	91.67%	NA
Prairie	32	21	65.63%	NA
Pineland	25	21	84.00%	NA
Total	104	84	80.77%	99.96%

Table 55: Number of sites sampled, sites at which *Rana sphenocephala* was detected, and the minimum (naïve) and PAO estimate of the site occupancy rate by habitat.

Habitat	Number of Sites	Number of Sites with Detection	Naïve Occupancy Rate	PAO Estimate
Cypress	18	14	77.78%	100.00%
Cypress Prairie	17	13	76.47%	93.33%
Hammock	12	9	75.00%	100.00%
Prairie	32	27	84.38%	99.51%
Pineland	25	16	64.00%	100.00%
Total	104	79	75.96%	98.79%

Table 56: Numbers of individual caudates captured by different survey methods.

Survey Method	Amphiuma means	Notophthalmus viridescens	Pseudobranchus axanthus	Siren lacertina
VES	4	1	0	0
Opportunistic Encounter	4	3	0	1
Drift Fences	0	0	1	7
Total	8	4	1	8

Table 57: Reptiles believed to potentially occur in Big Cypress National Preserve, whether they are introduced, and whether they were encountered during this study.

Class	Species	Introduced	This Study
Crocodilians	*Alligator mississippiensis*		X
	Crocodylus acutus		
Lizards	*Anolis carolinensis*		X
	Anolis sagrei	X	X
	Eumeces inexpectatus		X
	Hemidactylus garnotii	X	X
	Hemidactylus mabouia	X	X
	Hemidactylus tursicus	X	
	Iguana iguana	X	X
	Ophisaurus compressus		X
	Scincella lateralis		X
Snakes	*Agkistrodon piscivorus conanti*		X
	Cemophora coccinea coccinea		X
	Coluber constrictor paludicola		X
	Crotalus adamanteus		X
	Diadophis punctatus punctatus		X
	Drymarchon corais		
	Elaphe guttata guttata		X
	Elaphe obsoleta quadrivittata		X
	Farancia abacura		
	Lampropeltis getula floridana		X
	Lampropeltis triangulum elapsoides		X
	Micrurus fulvius		
	Nerodia clarkii		
	Nerodia fasciata pictiventris		X
	Nerodia floridana		X
	Nerodia taxispilota		X
	Opheodrys aestivus		X
	Python molorus	X	
	Ramphotyphlops braminus	X	
	Regina alleni		X
	Seminatrix pygea cyclas		X
	Sistrurus miliarius barbouri		X
	Storeria dekayi victa		X
	Thamnophis sauritus sackenii		X
	Thamnophis sirtalis sirtalis		X

Table 57 (continued)

Class	Species	Introduced	This Study
Turtles	*Apolone ferox*		X
	Chelydra serpentina osceola		X
	Deirochelys reticularia		X
	Gopherus polyphemus		
	Kinosternon baurii		X
	Kinosternon subrubrum		
	Pseudemys floridana peninsularis		X
	Pseudemys nelsoni		X
	Sternotherus odoratus		
	Terrapene carolina baurii		X

Table 58: Reptile species found in Big Cypress National Preserve and the survey methods by which they were detected

Class	Species	Common Name	Opportunistic Encounter	VES
Crocodilians	*Alligator mississippiensis*	American alligator		X
Lizards	*Anolis carolinensis*	green anole		X
	Anolis sagrei	brown anole		X
	Eumeces inexpectatus	southeastern five-lined skink		X
	Hemidactylus garnotii	Indo-Pacific gecko	X	
	Hemidactylus mabouia	tropical house gecko		X
	Iguana iguana	green iguana	X	
	Ophisaurus compressus	island glass lizard	X	
	Scincella lateralis	ground skink		X
Snakes	*Agkistrodon piscivorus conanti*	Florida cottonmouth	X	X
	Cemophora coccinea coccinea	Florida scarlet snake	X	
	Coluber constrictor paludicola	Everglades racer	X	X
	Crotalus adamanteus	eastern diamondback rattlesnake	X	
	Diadophis punctatus punctatus	southern ringneck snake	X	
	Elaphe guttata guttata	corn snake		X
	Elaphe obsoleta quadrivittata	yellow rat snake	X	X
	Lampropeltis getula floridana	Florida kingsnake	X	
	Lampropeltis triangulum elapsoides	scarlet kingsnake	X	
	Nerodia fasciata pictiventris	Florida water snake	X	X
	Nerodia floridana	Florida green water snake	X	X
	Nerodia taxispilota	brown water snake	X	
	Opheodrys aestivus	rough green snake	X	
	Regina alleni	striped crayfish snake	X	X
	Seminatrix pygea cyclas	South Florida swamp snake	X	
	Sistrurus miliarius barbouri	dusky pigmy rattlesnake	X	
	Storeria dekayi victa	Florida brown snake	X	
	Thamnophis sauritus sackenii	peninsula ribbon snake	X	X

Table 58 (continued)

Class	Species	Common Name	Opportunistic Encounter	VES
	Thamnophis sirtalis sirtalis	eastern garter snake	X	X
Turtles	*Apolone ferox*	Florida softshell turtle	X	
	Chelydra serpentina osceola	Florida snapping turtle	X	X
	Deirochelys reticularia	Chicken turtle	X	
	Kinosternon baurii	striped mud turtle	X	X
	Pseudemys floridana peninsularis	peninsula cooter	X	X
	Pseudemys nelsoni	Florida redbelly turtle	X	X
	Terrapene carolina baurii	Florida box turtle	X	X

Figures

Legend

Big Cypress National Preserve

0   15   30   60   90
Kilometers
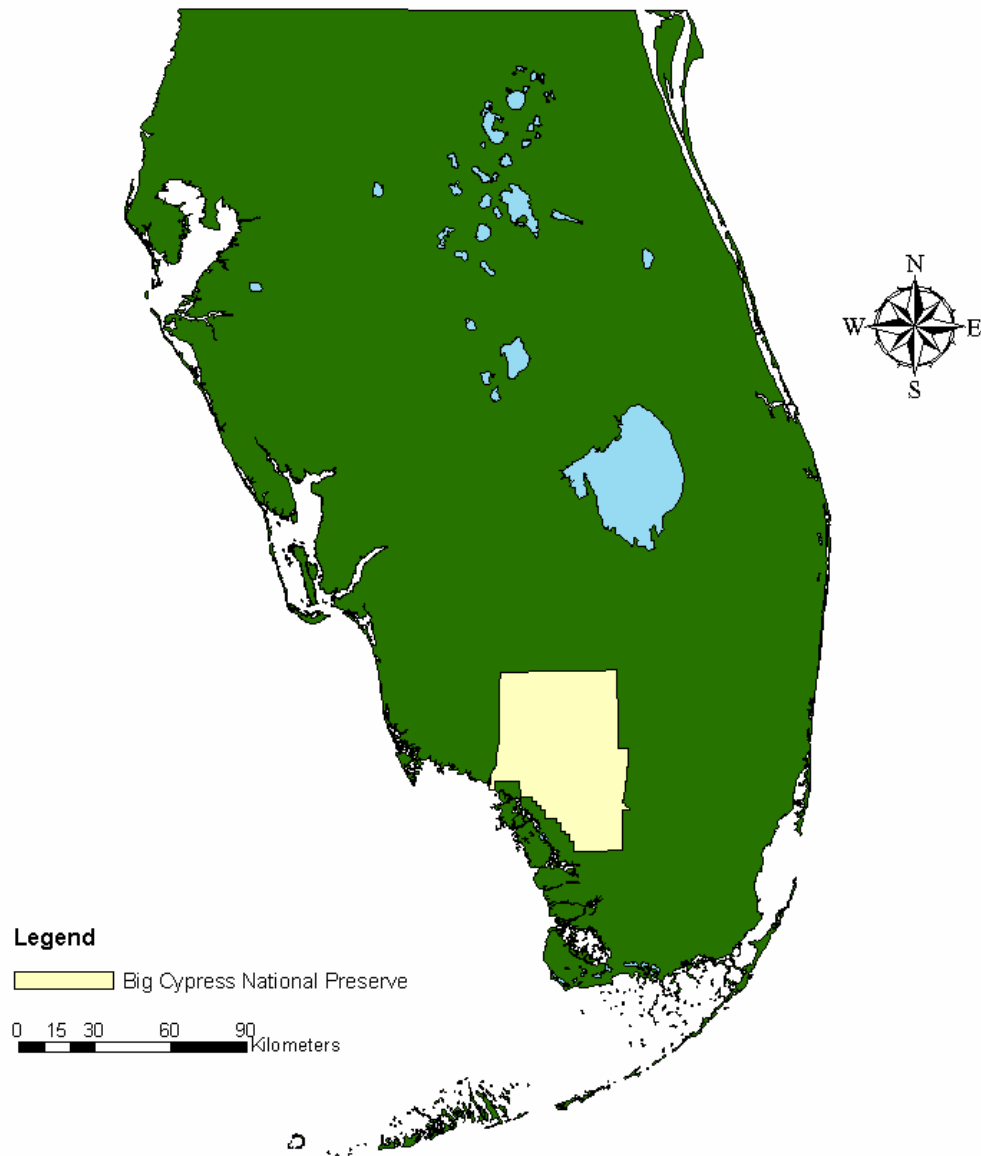
Figure 1: Map of Florida showing location of Big Cypress National Preserve.
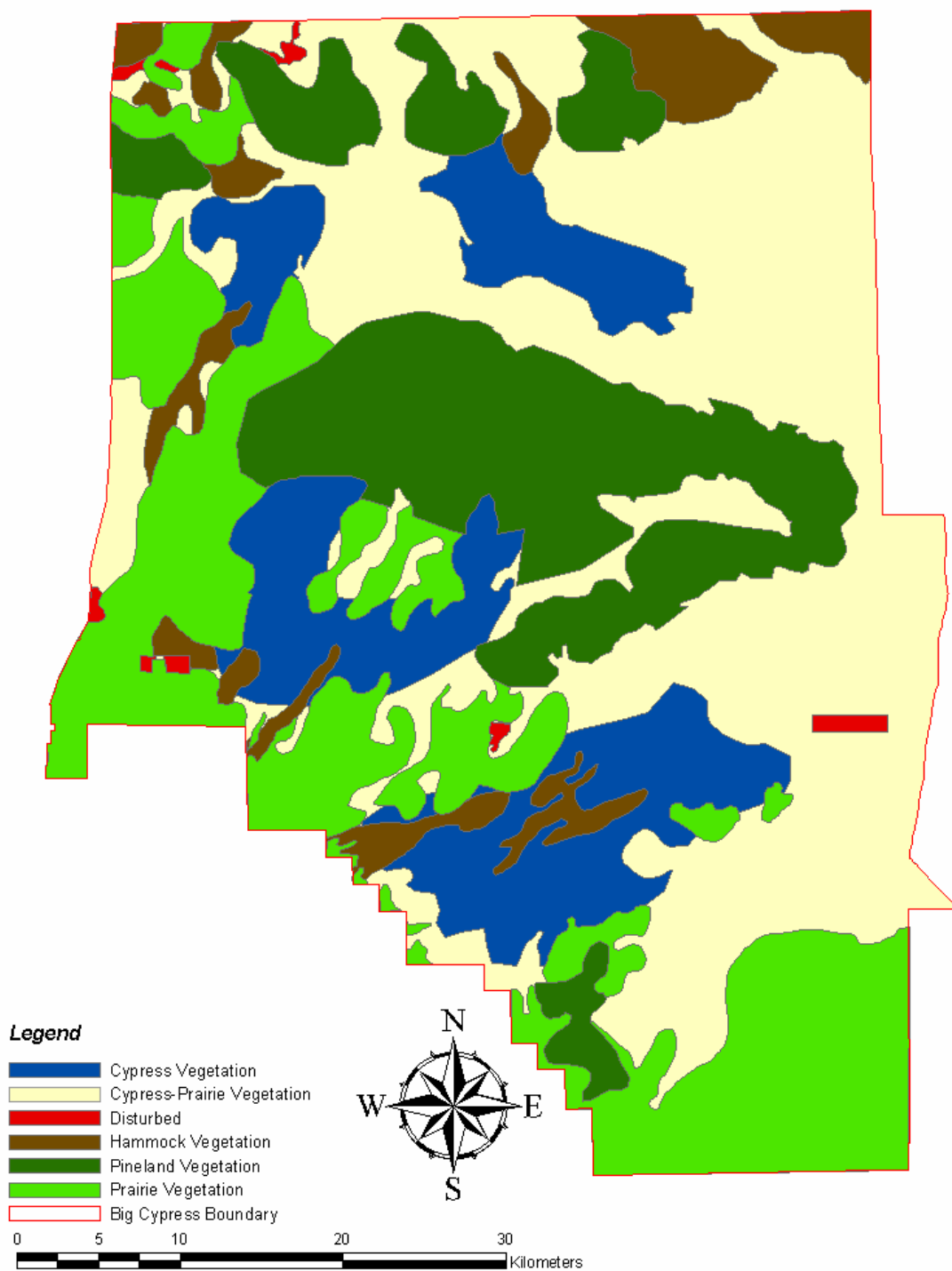
Figure 2: Vegetation classification of Big Cypress National Preserve.
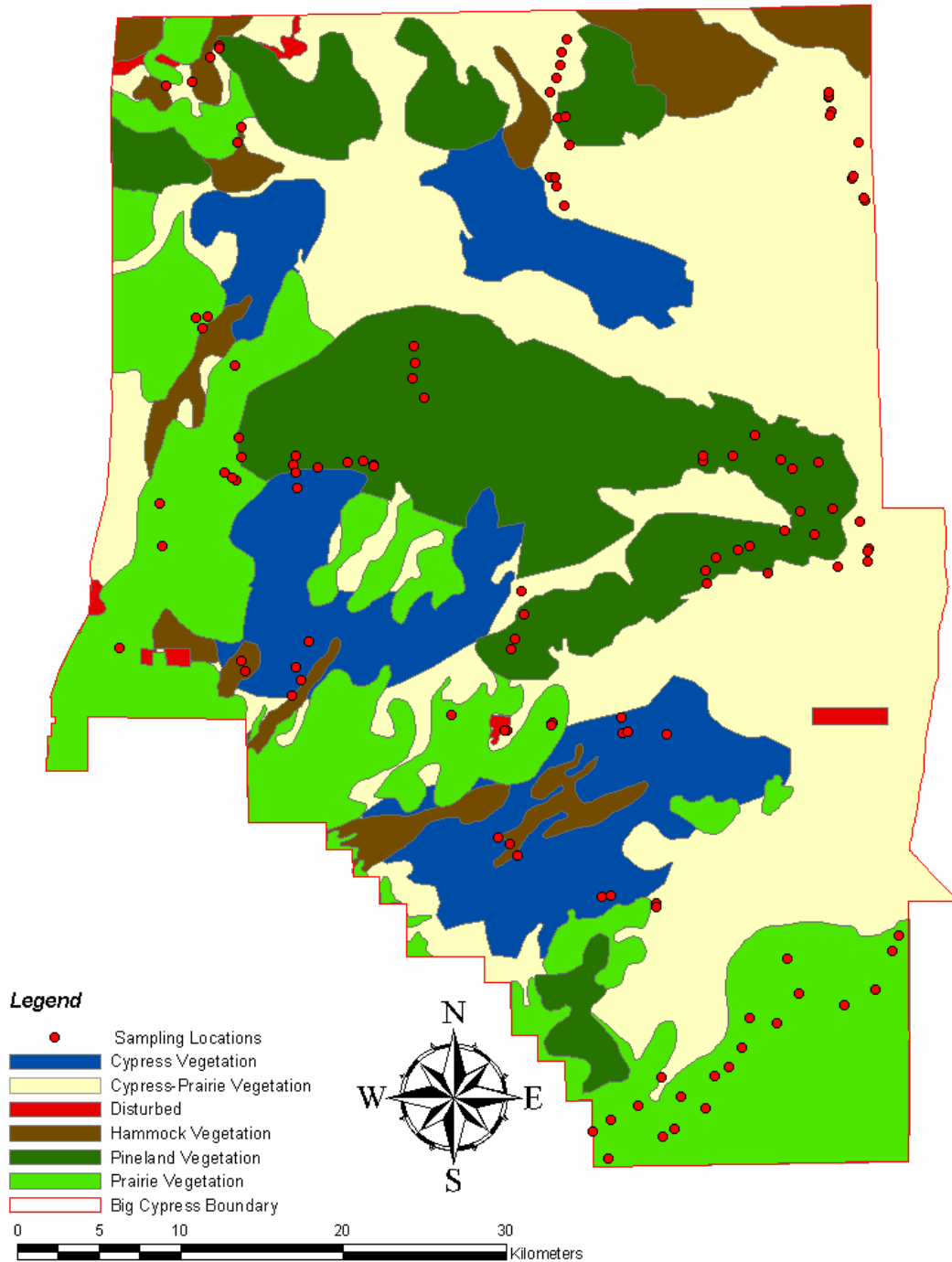
Figure 3: Standard sampling site locations.
Map of all Standard Sampling locations at which VES and Vocalization surveys were conducted at Big Cypress National Preserve.
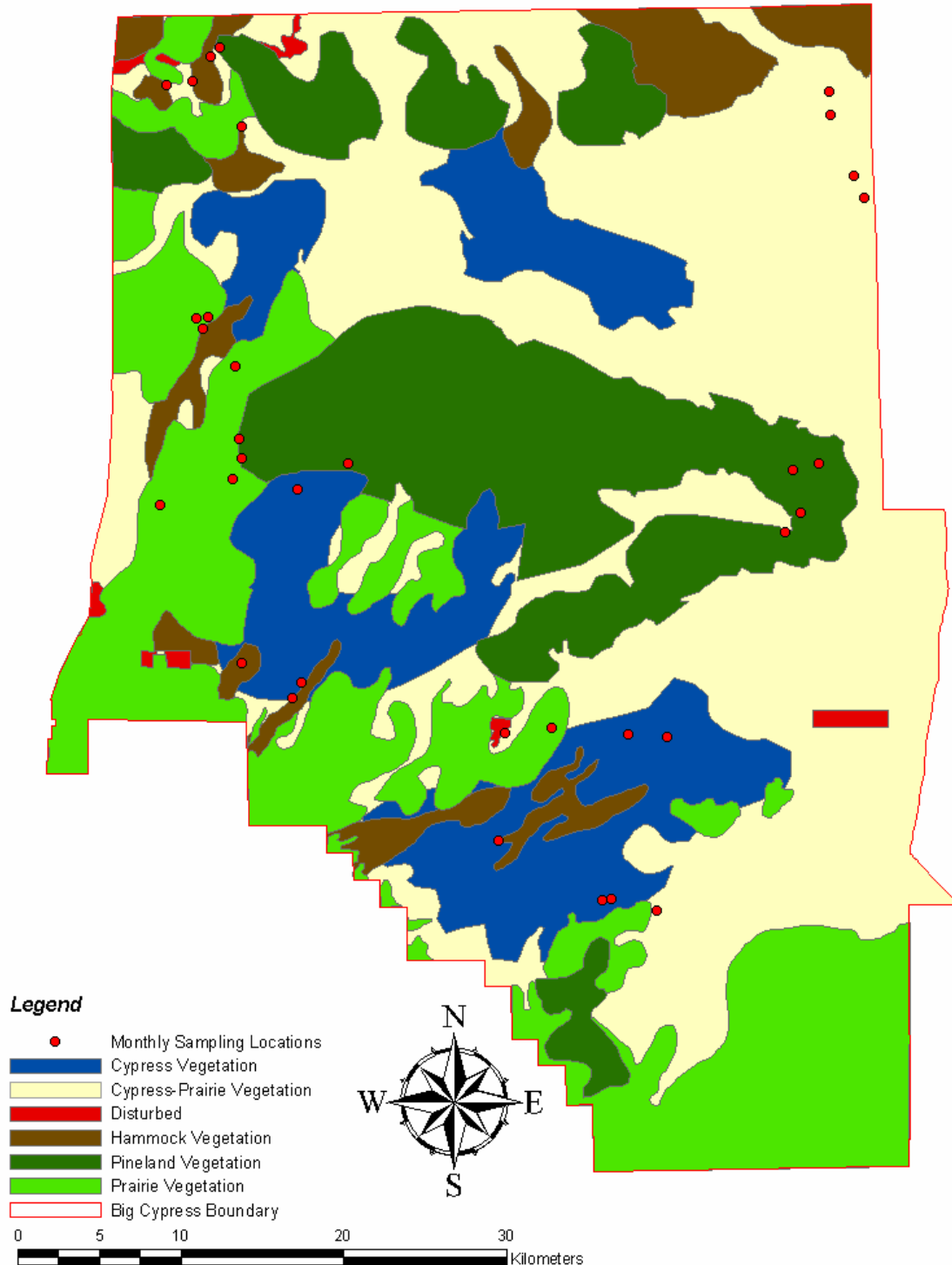
Figure 4: Sites sampled on a monthly basis.
Map of all locations at which VES and Vocalization surveys were conducted on a monthly basis at Big Cypress National Preserve.
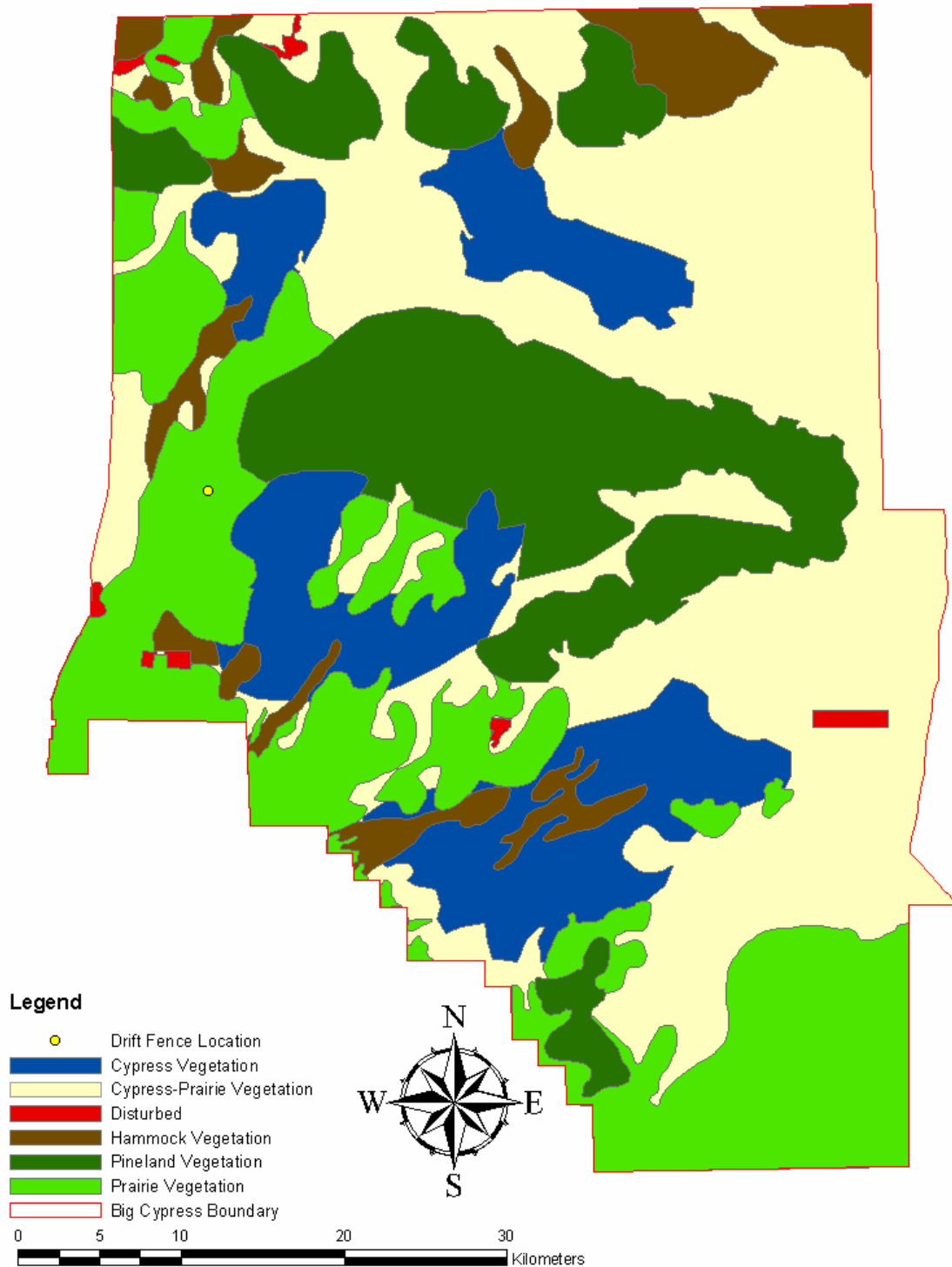
Figure 5: Location of drift fences.
Map of the location at which Drift Fence surveys were conducted at Big Cypress National Preserve.
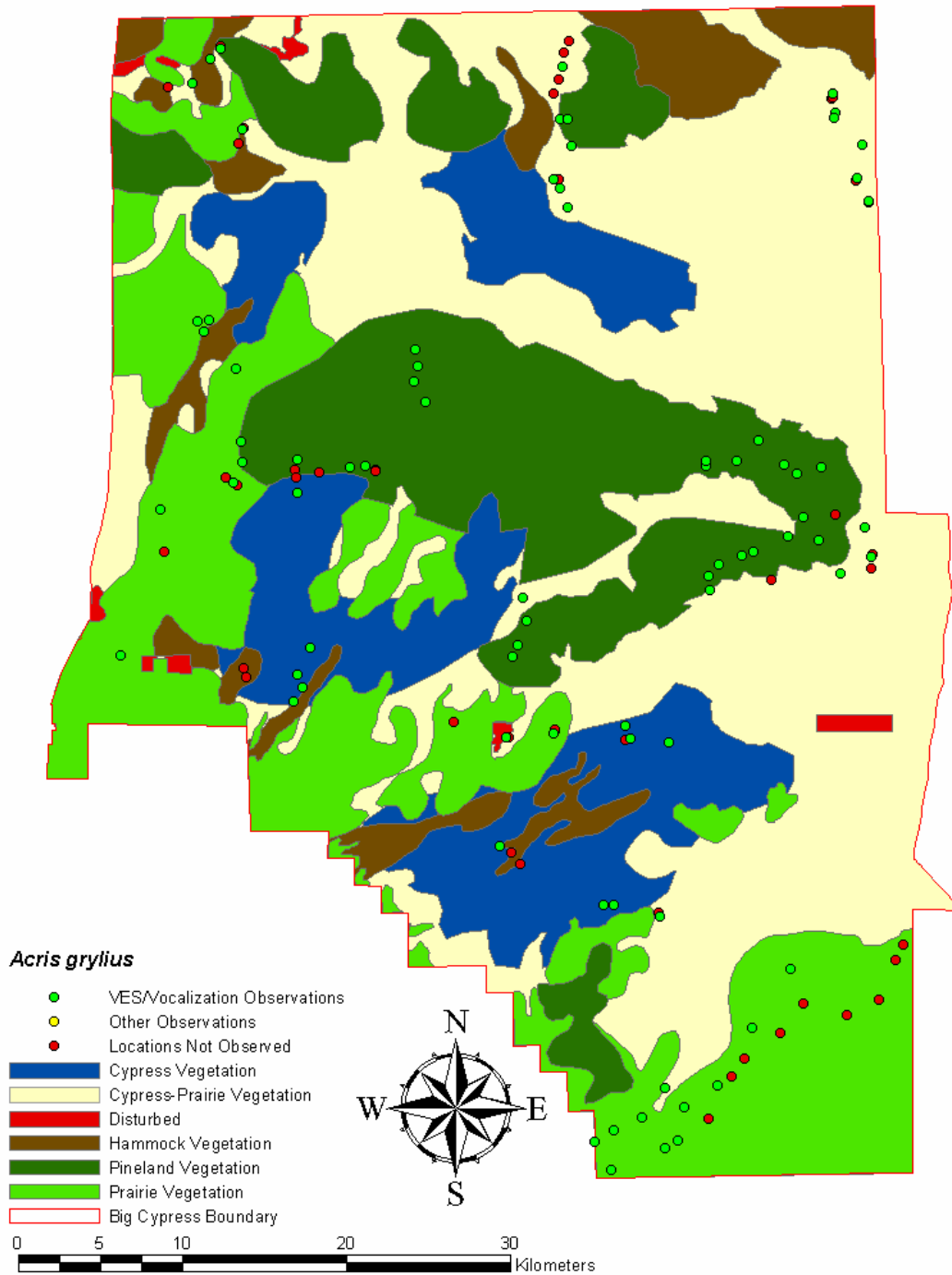
Figure 6: *Acris gryllus* locations.
Map of all locations at which *Acris gryllus* were observed in Big Cypress National Preserve.
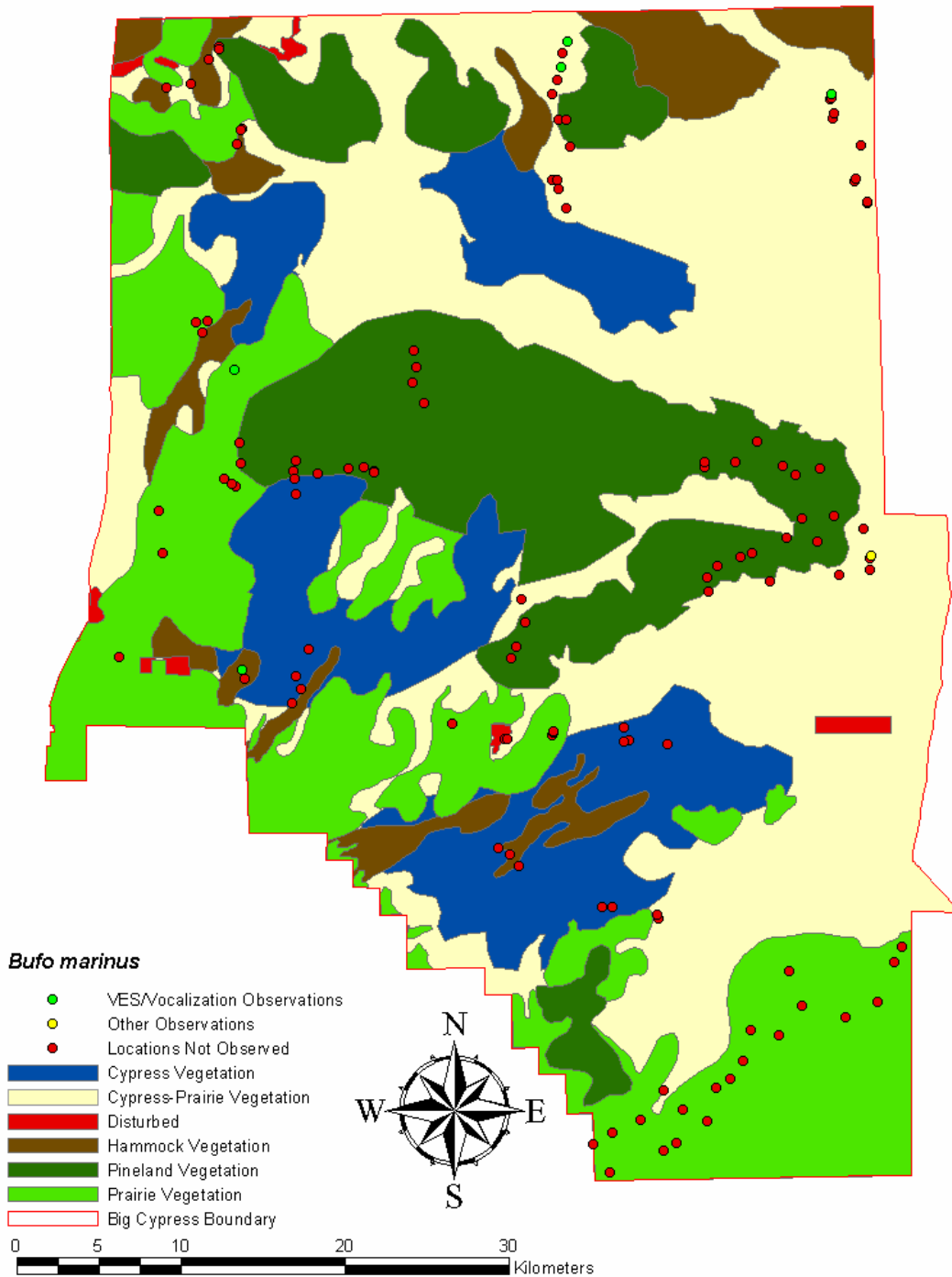
Figure 7: *Bufo marinus* locations.
Map of all locations at which *Bufo marinus* were observed in Big Cypress National Preserve.
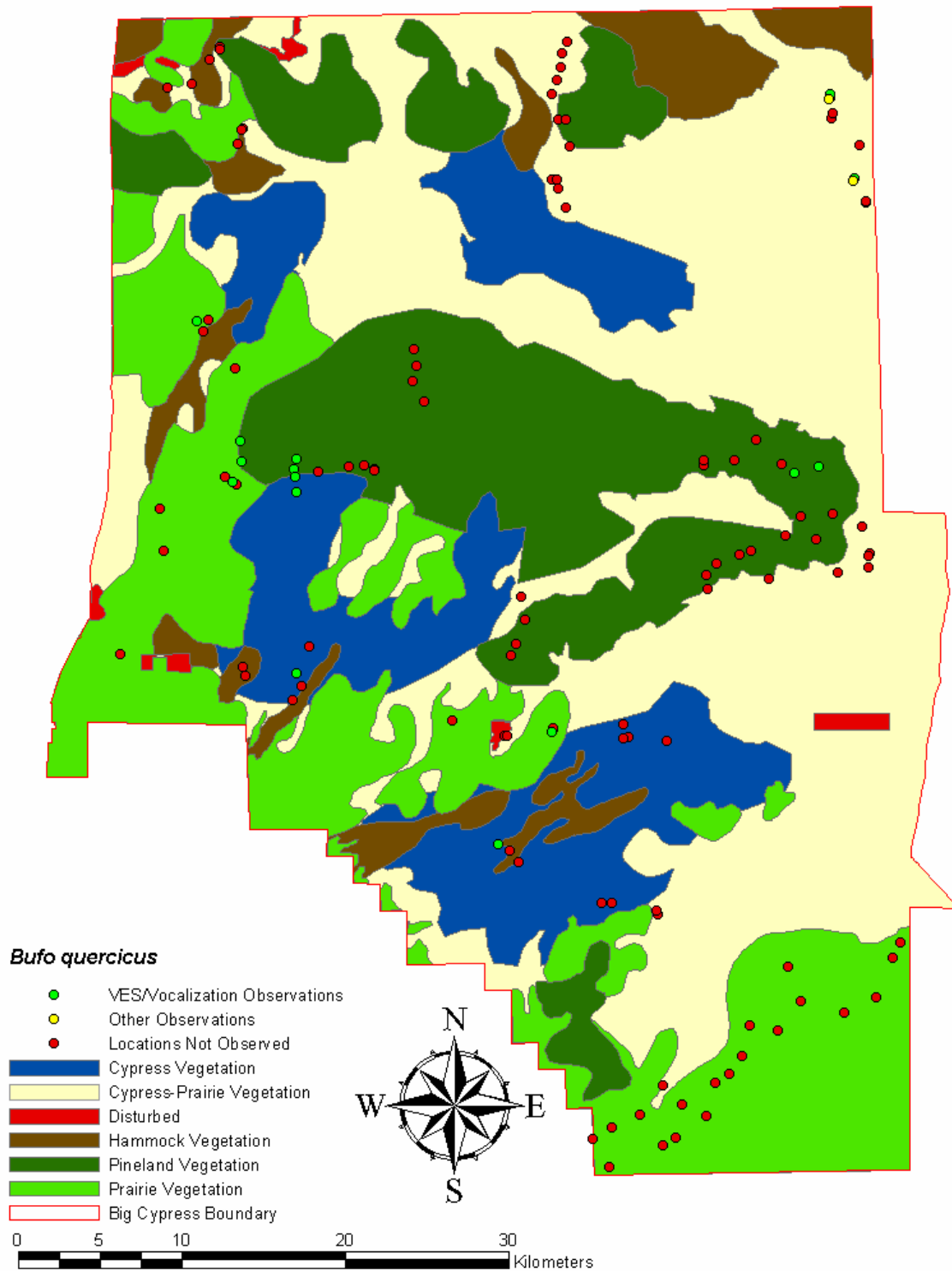
Figure 8: *Bufo quercicus* locations.
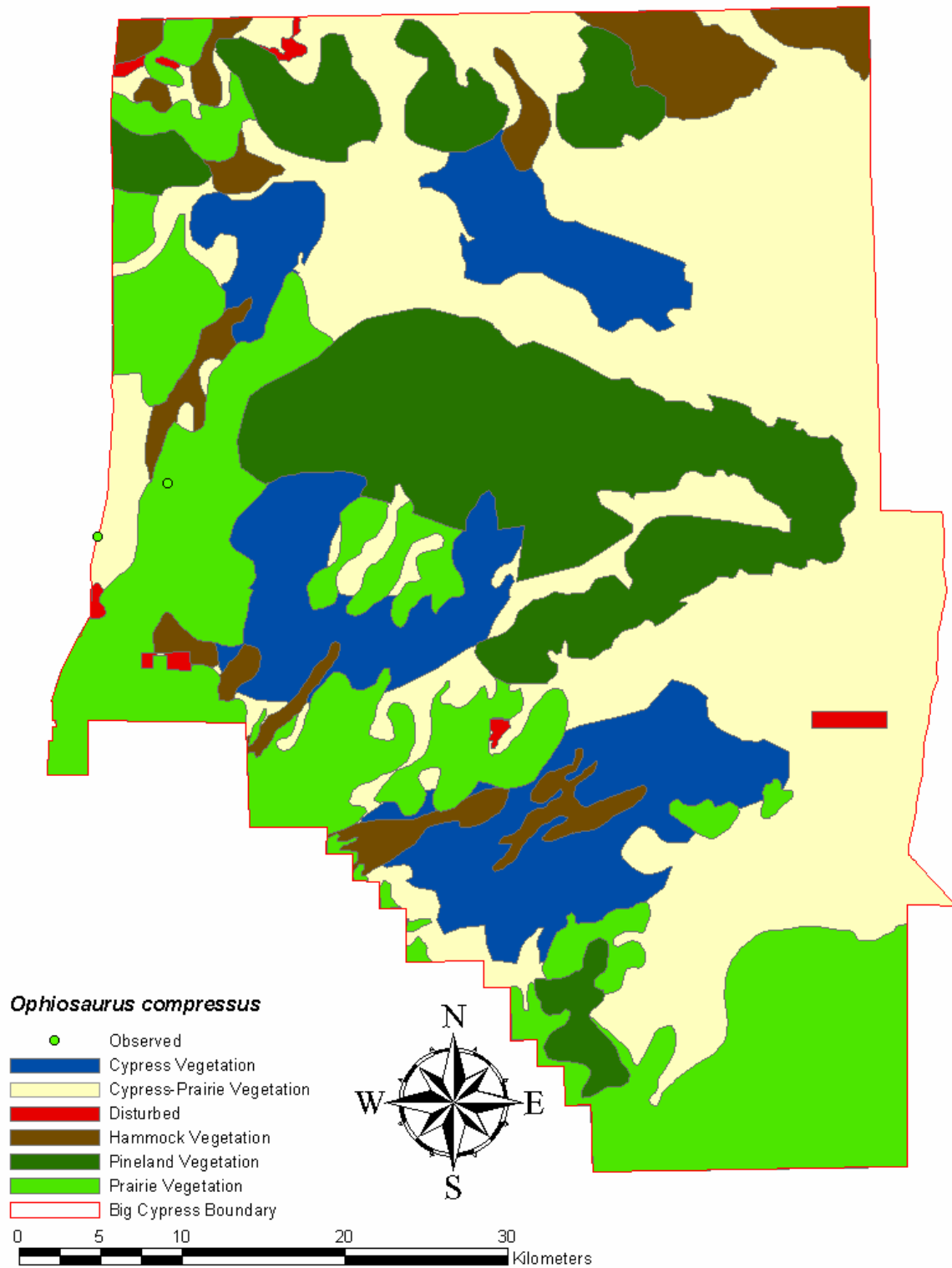Map of all locations at which *Bufo quercicus* were observed in Big Cypress National Preserve.
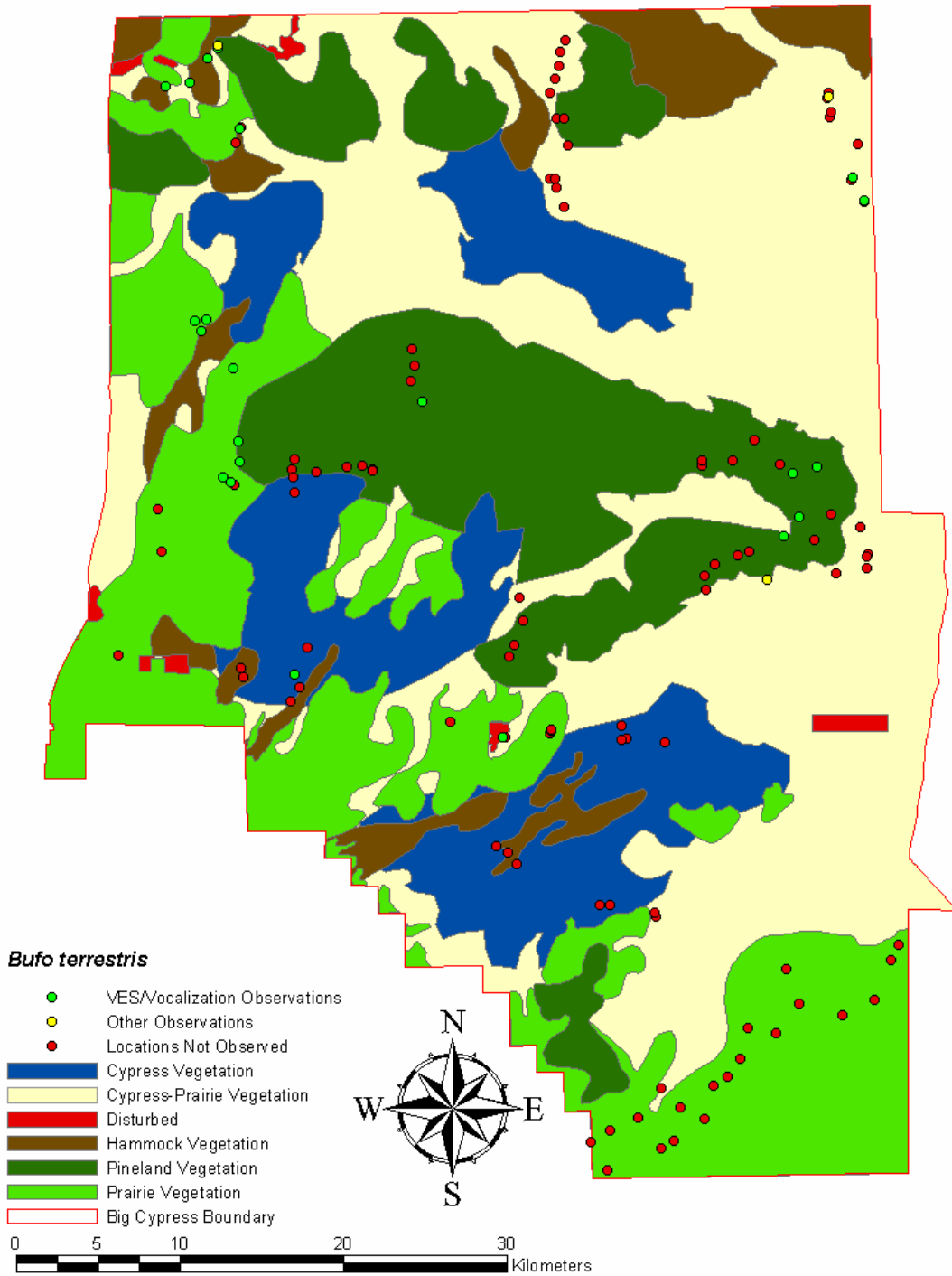
Figure 9: *Bufo terrestris* locations.
Map of all locations at which *Bufo terrestris* were observed in Big Cypress National .Preserve.
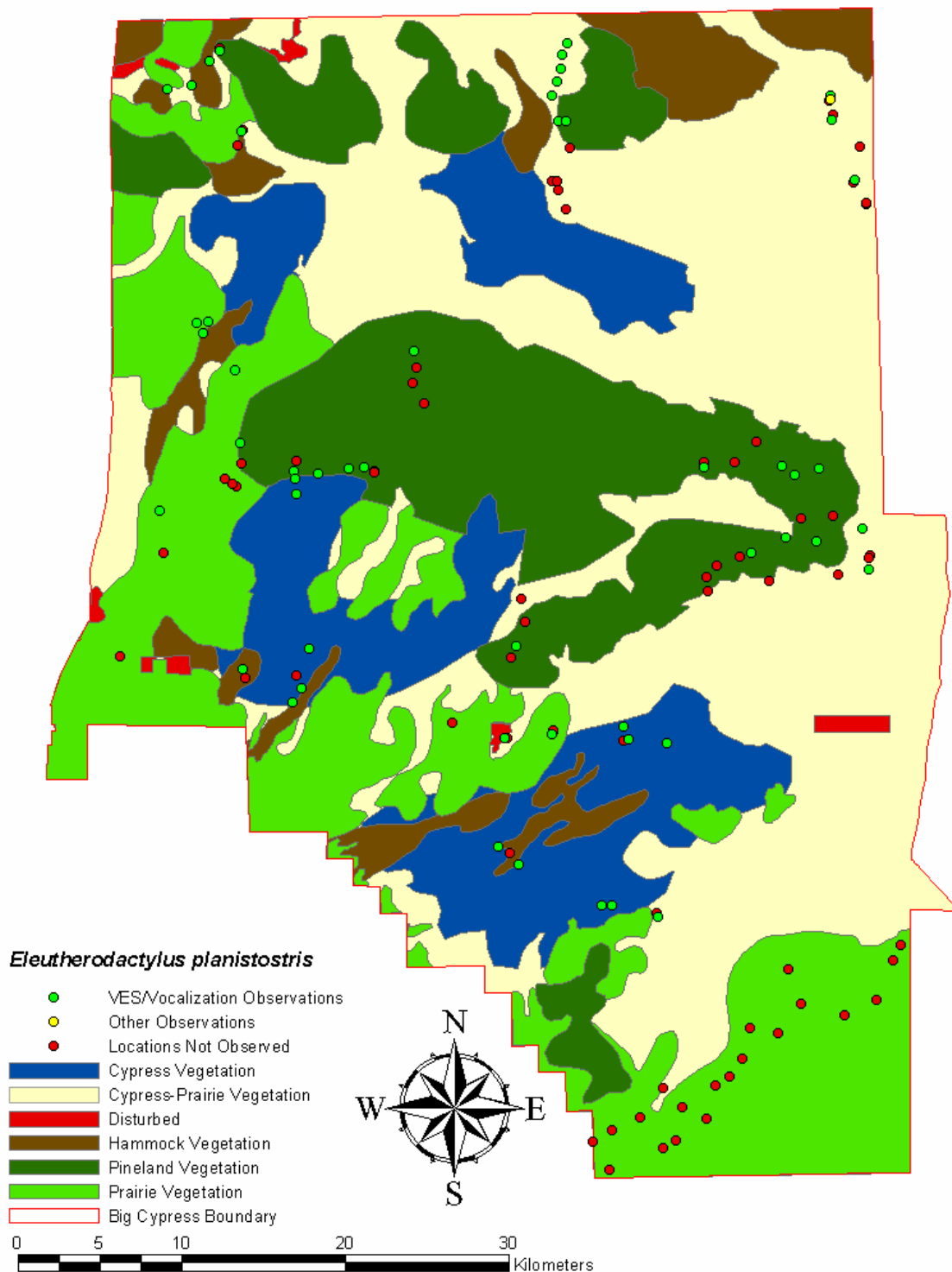
Figure 10: *Eleutherodactylus planirostris* locations.
Map of all locations at which *Eleutherodactylus planirostris* were observed in Big Cypress National Preserve.
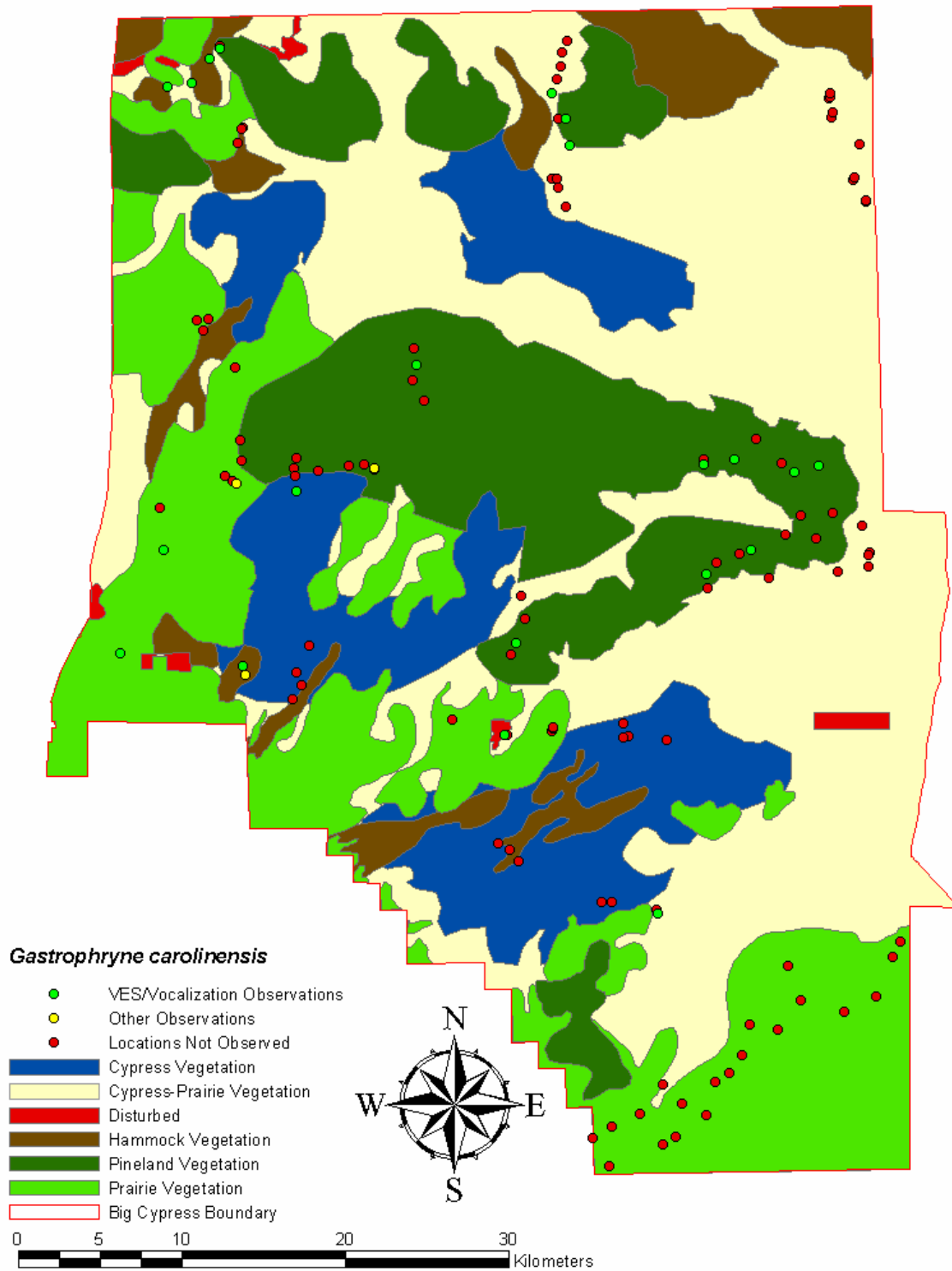
Figure 11: *Gastrophryne carolinensis* locations.
Map of all locations at which *Gastrophryne carolinensis* were observed in Big Cypress National Preserve.
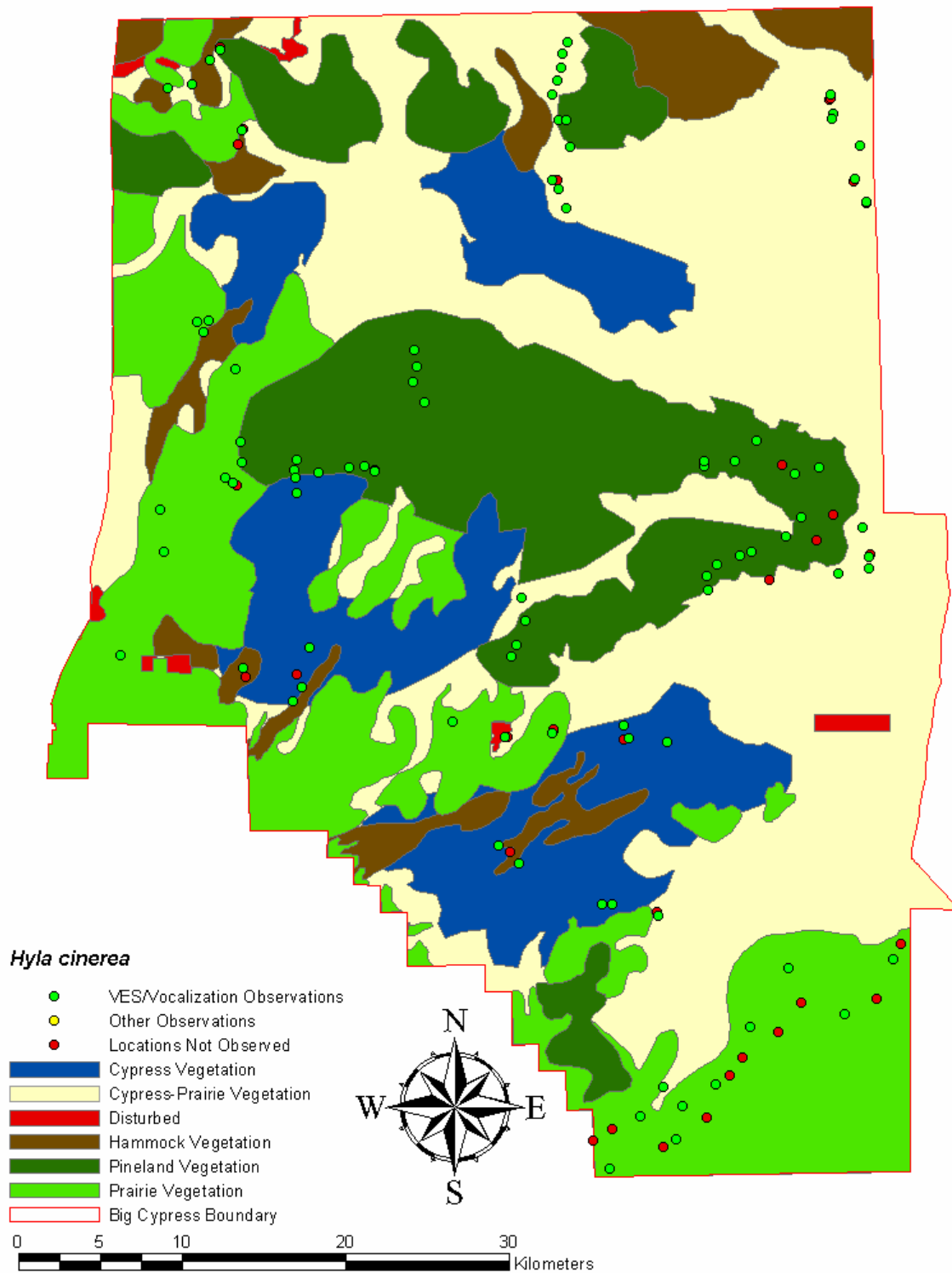
Figure 12: *Hyla cinerea* locations.
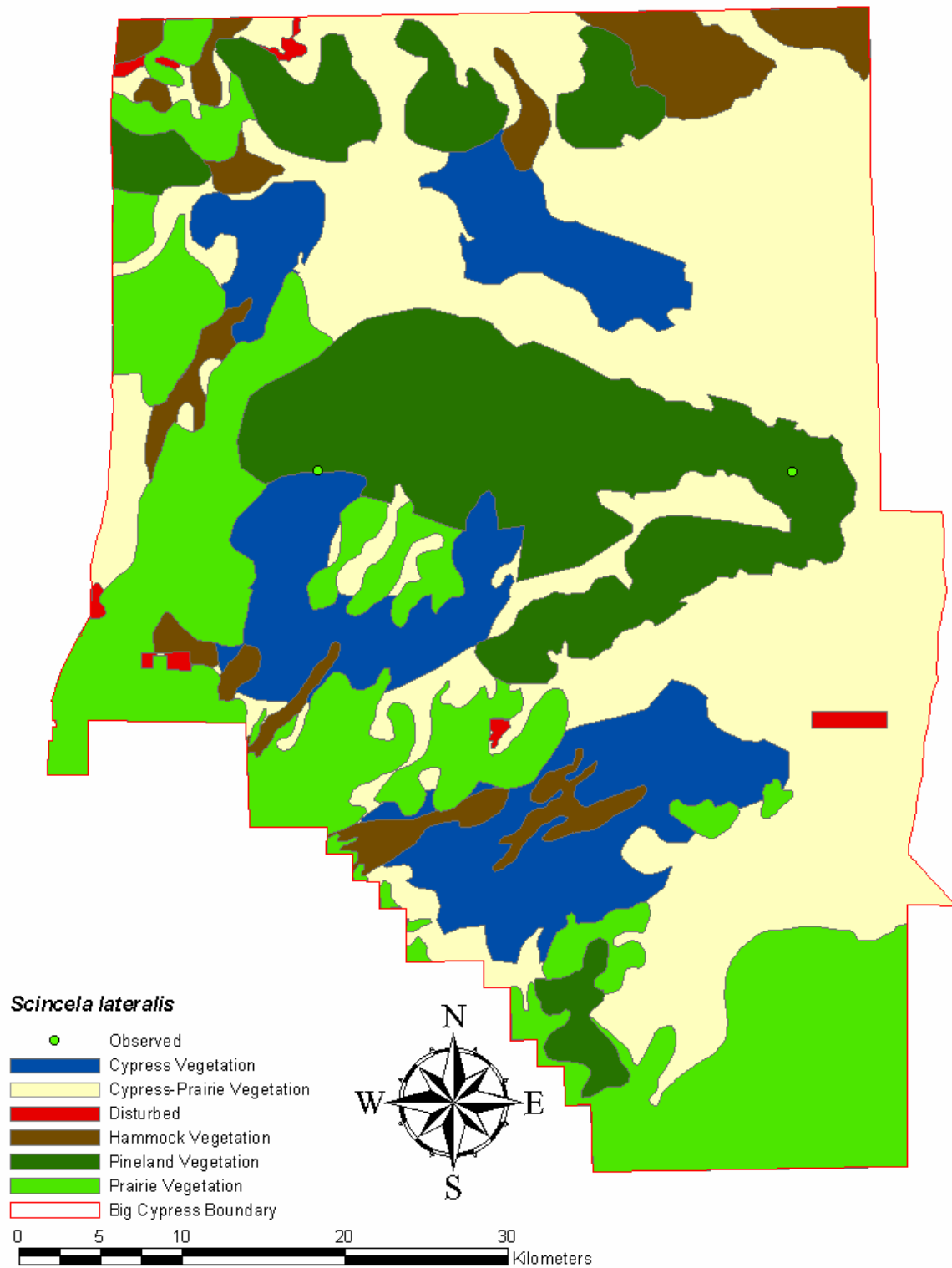Map of all locations at which *Hyla cinerea* were observed in Big Cypress National Preserve.
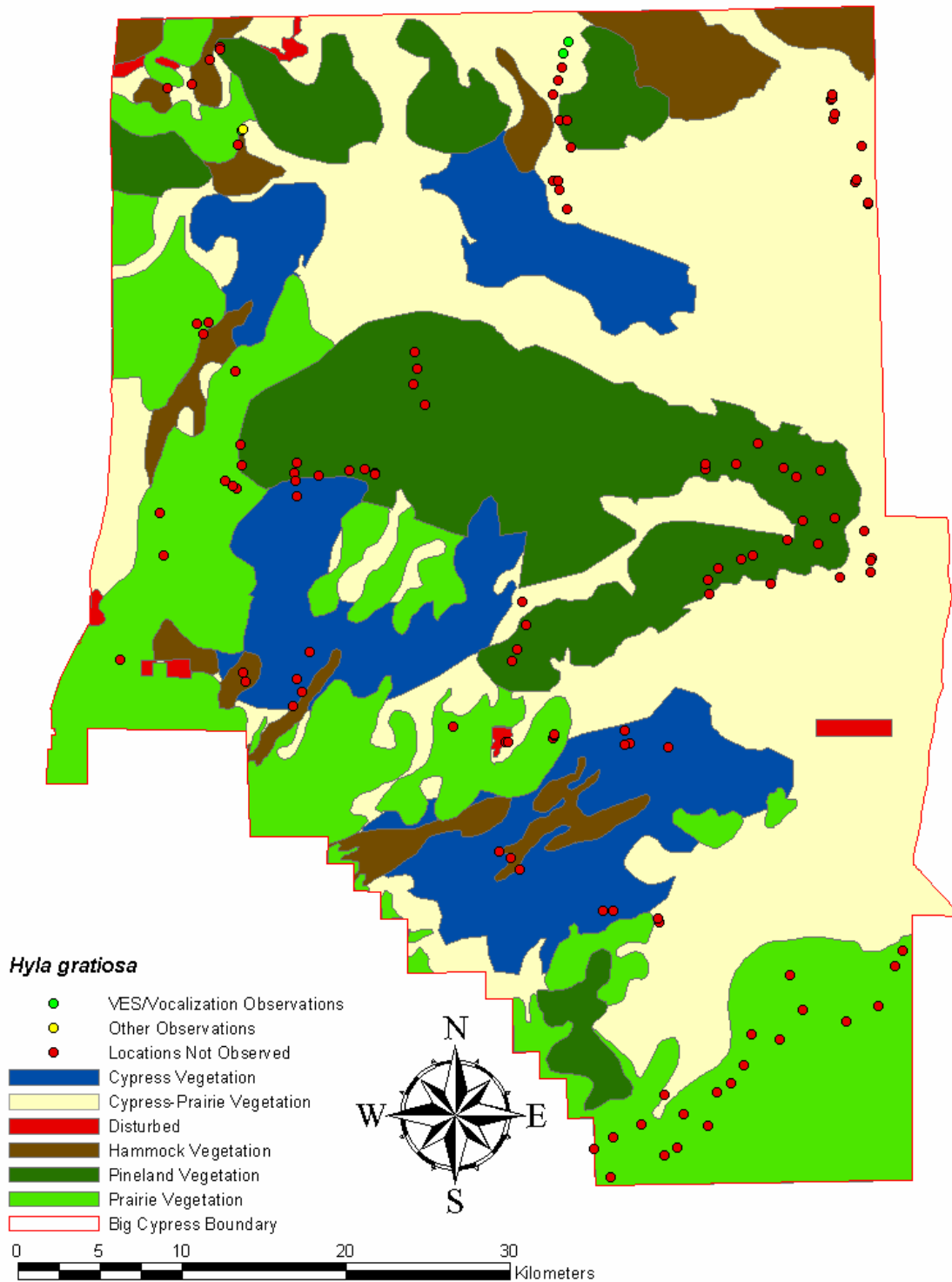
Figure 13: *Hyla gratiosa* locations.
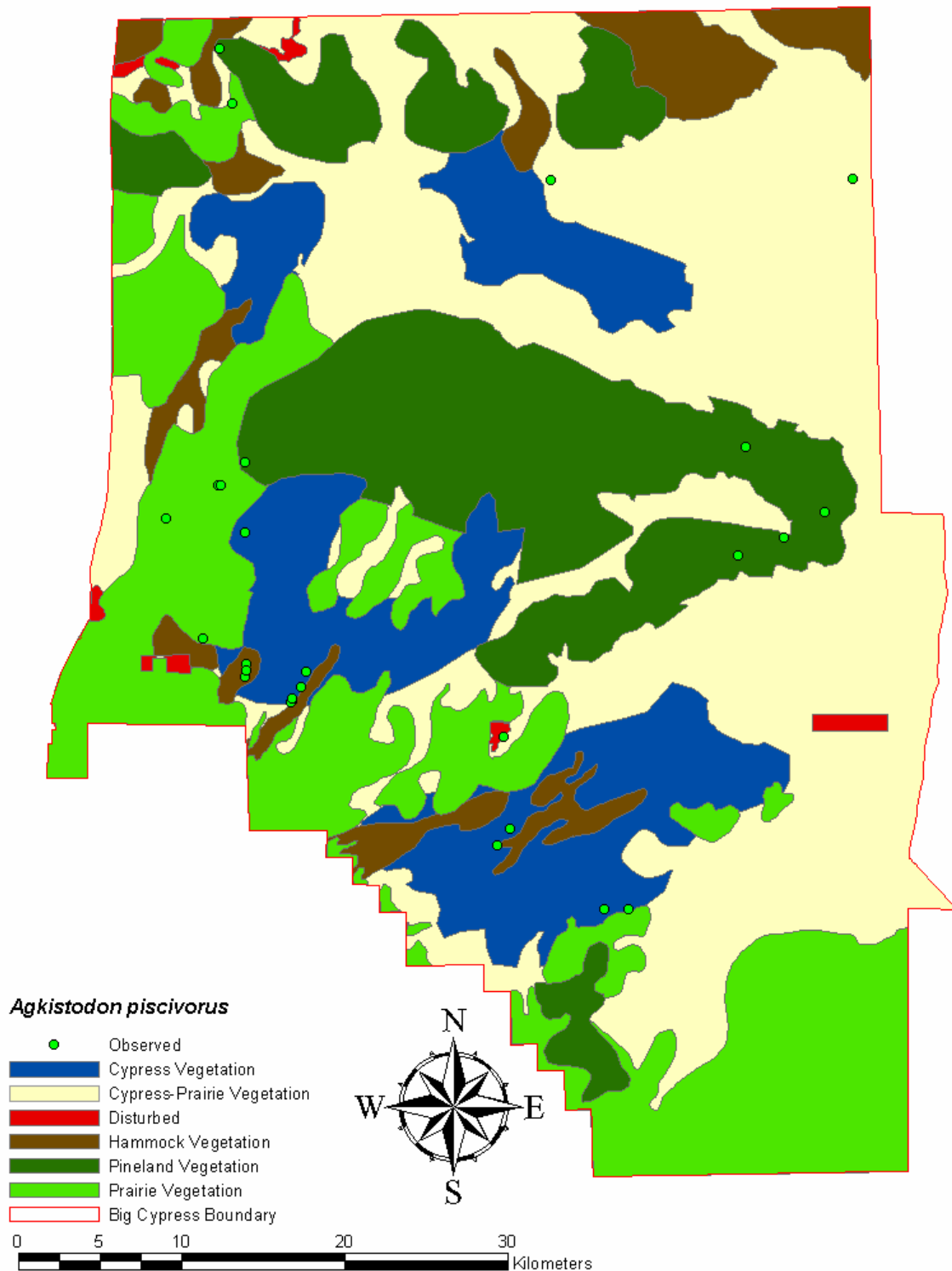Map of all locations at which *Hyla gratiosa* were observed in Big Cypress National Preserve.
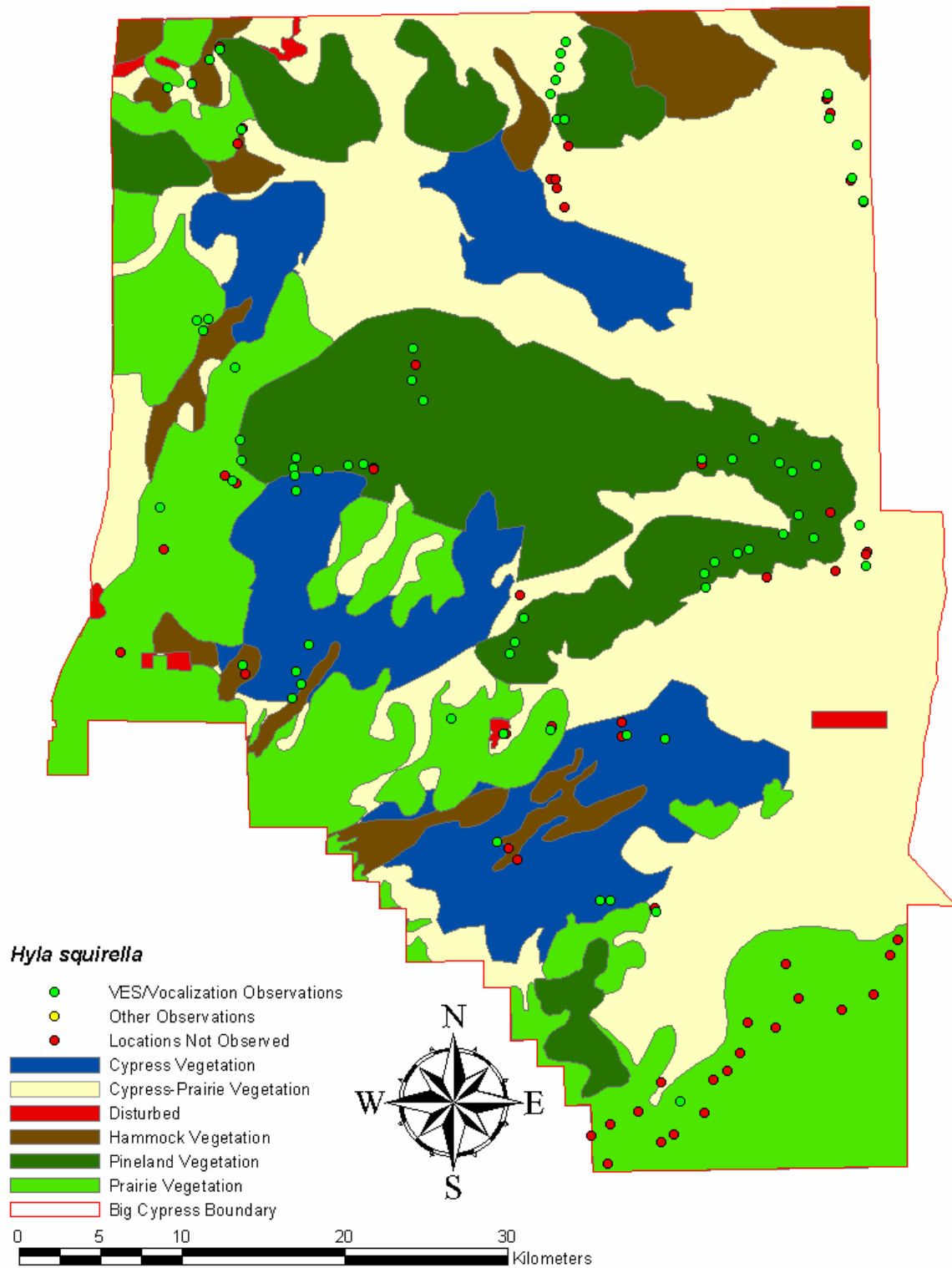
Figure 14: *Hyla squirella* locations.
Map of all locations at which *Hyla squirella* were observed in Big Cypress National Preserve.
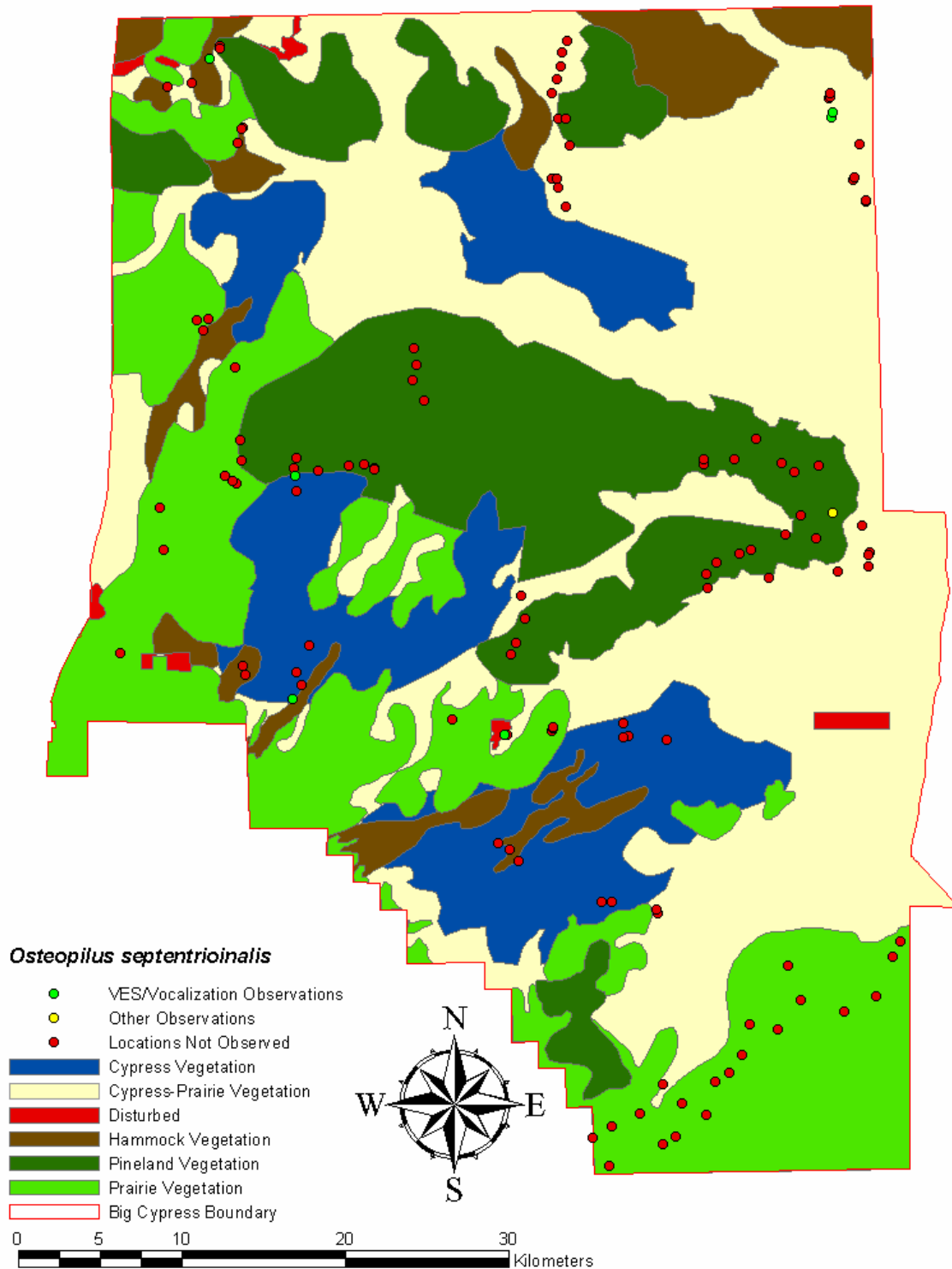
Figure 15: *Osteopilus septentrionalis* locations.
Map of all locations at which *Osteopilus septentrionalis* were observed in Big Cypress National Preserve.
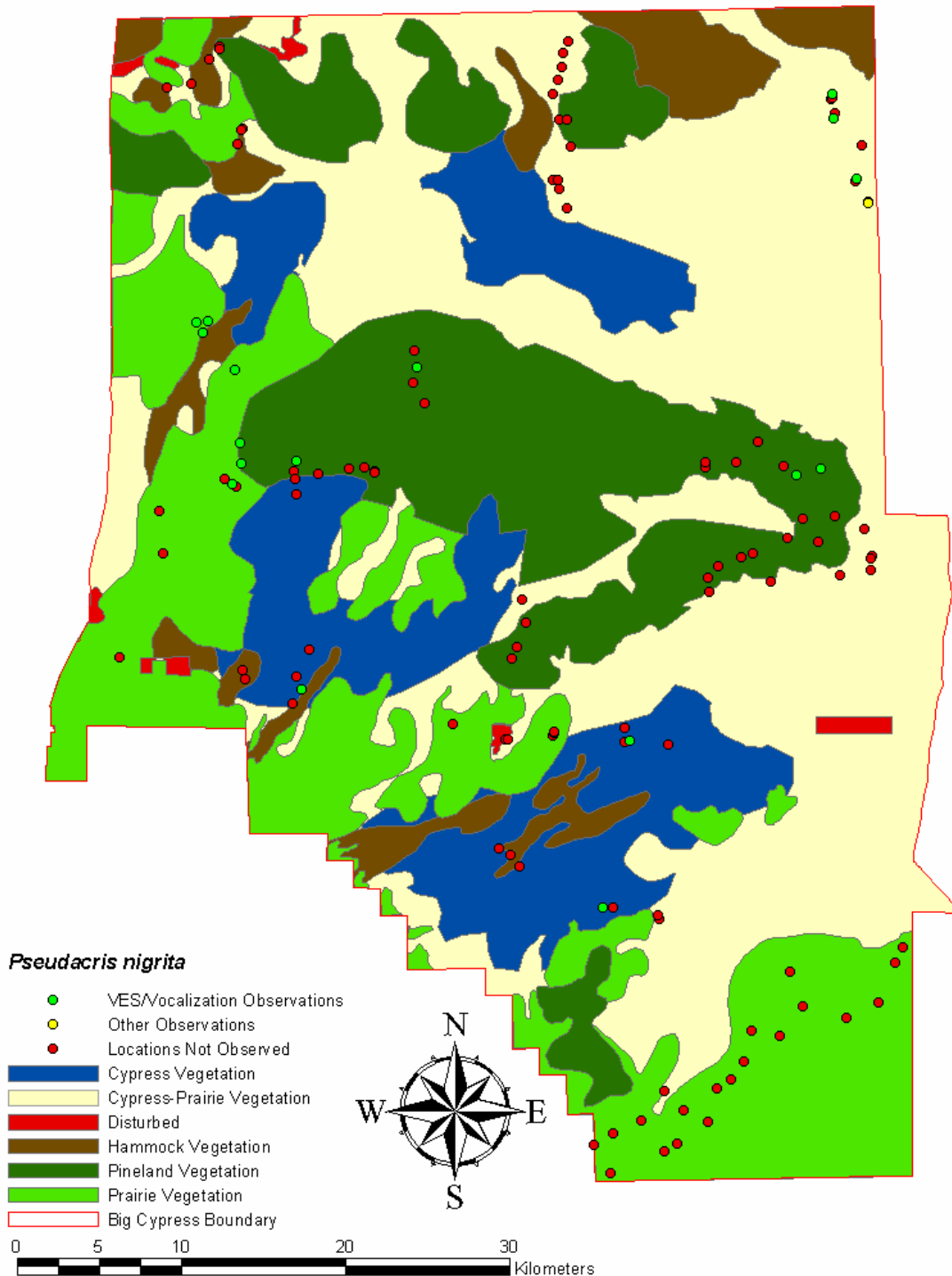
Figure 16: *Pseudacris nigrita* locations.
Map of all locations at which *Pseudacris nigrita* were observed in Big Cypress National Preserve.
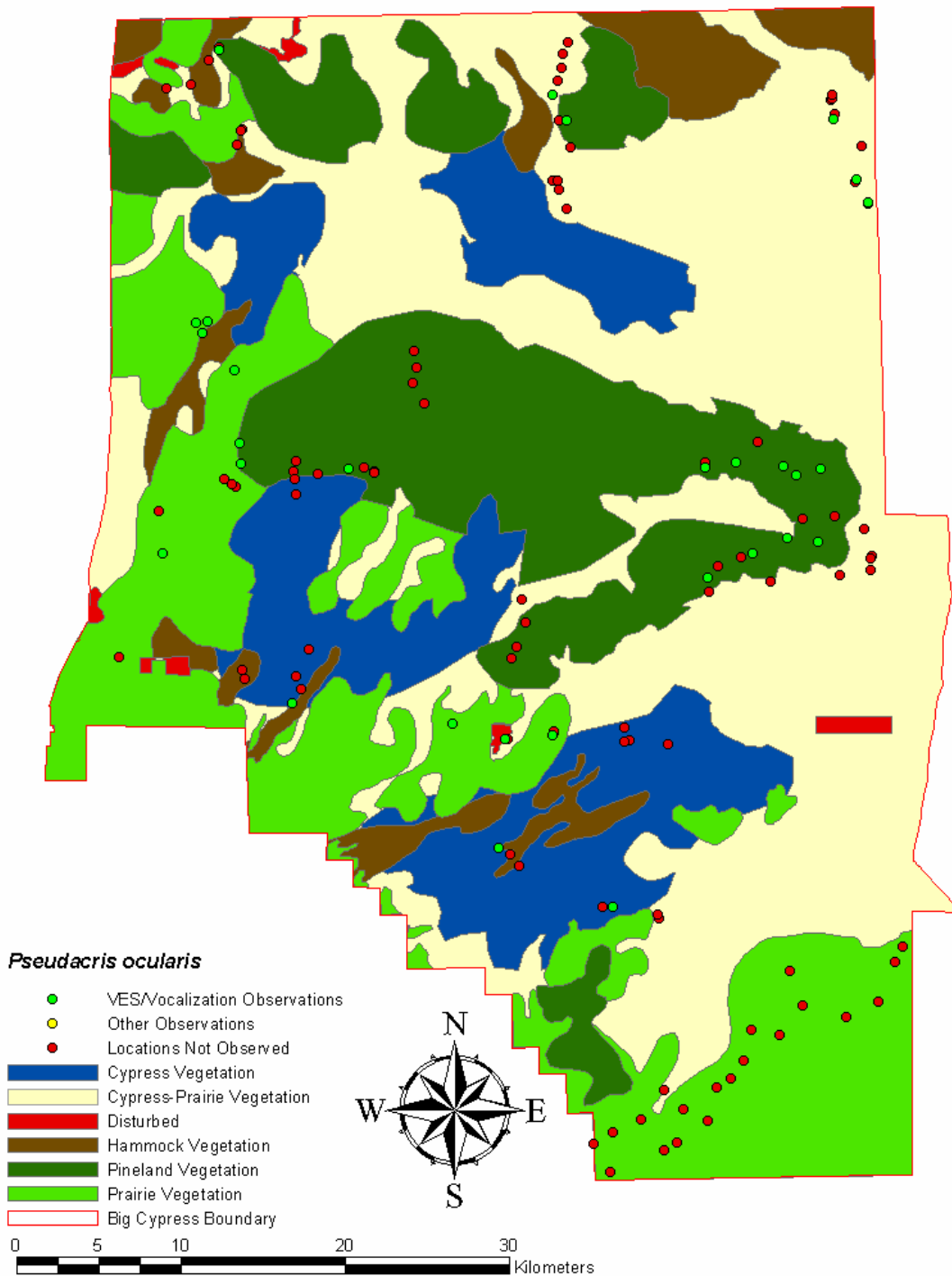
Figure 17: *Pseudacris ocularis* locations.
Map of all locations at which *Pseudacris ocularis* were observed in Big Cypress National Preserve.
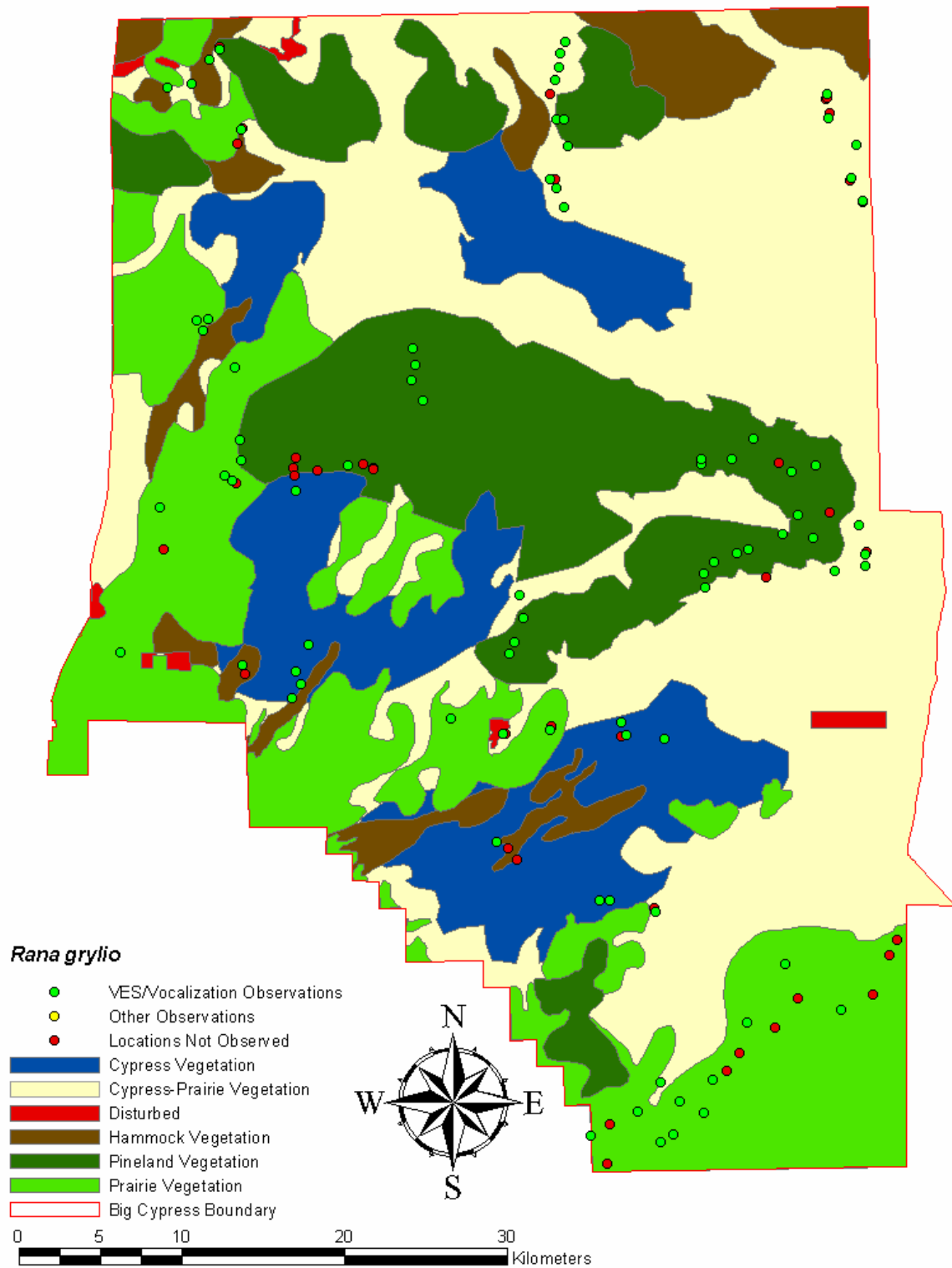
Figure 18: *Rana grylio* locations.
Map of all locations at which *Rana grylio* were observed in Big Cypress National Preserve
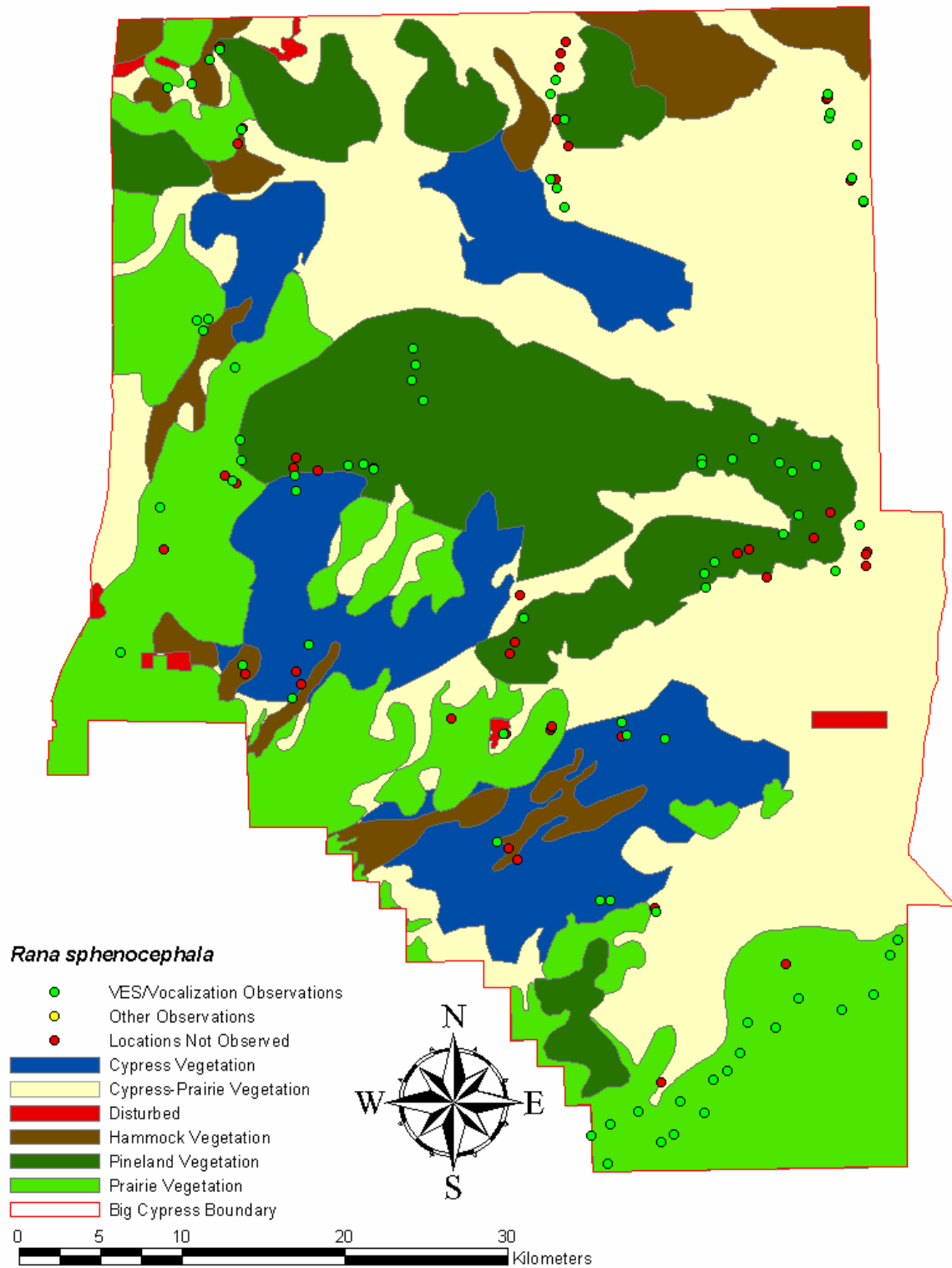
Figure 19: *Rana sphenocephala* locations.
Map of all locations at which *Rana sphenocephala* were observed in Big Cypress National Preserve

Amphiuma means

- ● VES/Vocalization Observations
- ● Other Observations
- ● Locations Not Observed
- ■ Cypress Vegetation
- ■ Cypress-Prairie Vegetation
- ■ Disturbed
- ■ Hammock Vegetation
- ■ Pineland Vegetation
- ■ Prairie Vegetation
- □ Big Cypress Boundary
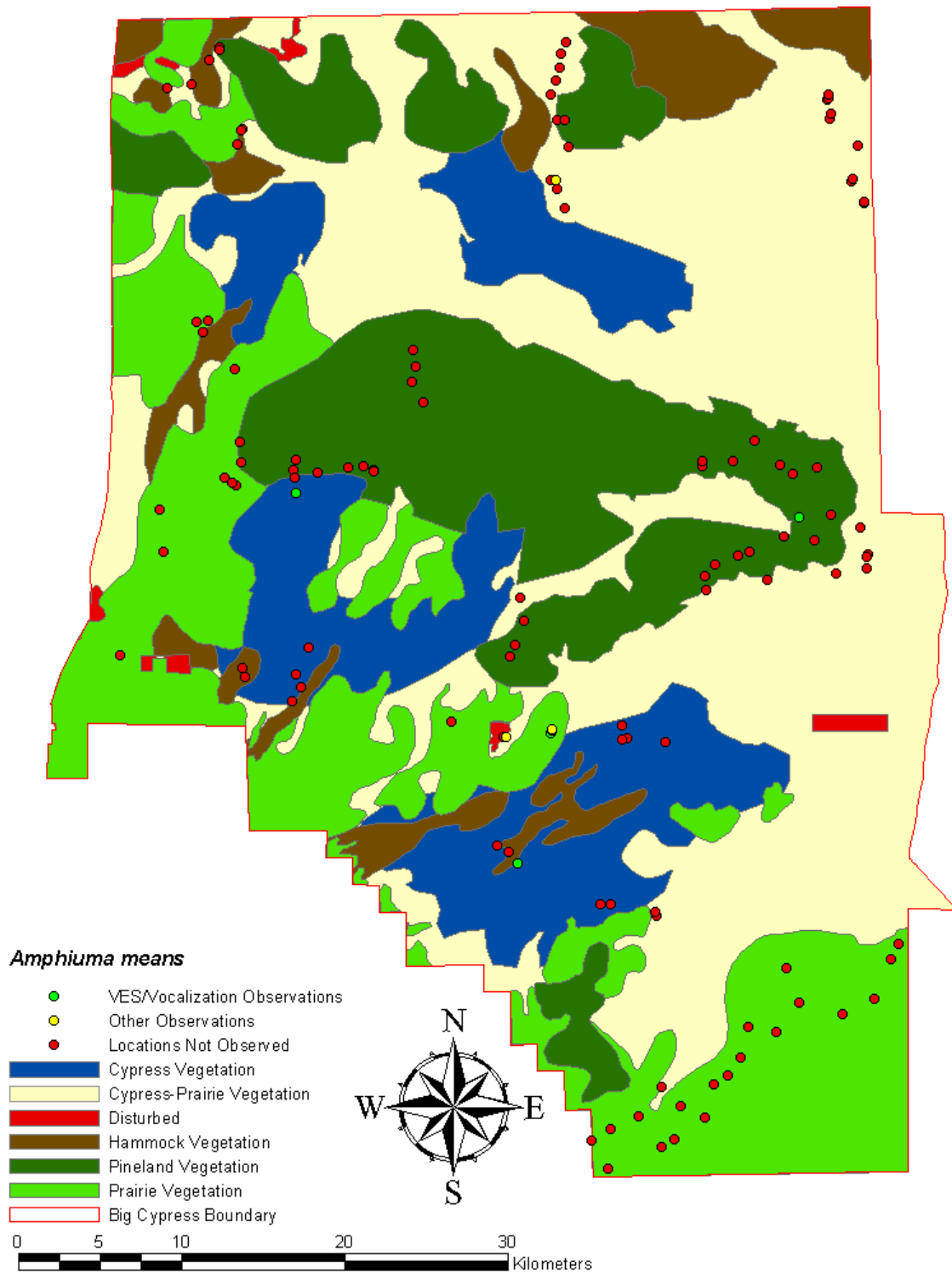
Figure 20: *Amphiuma means* locations.
Map of all locations at which *Amphiuma means* were observed in Big Cypress National Preserve
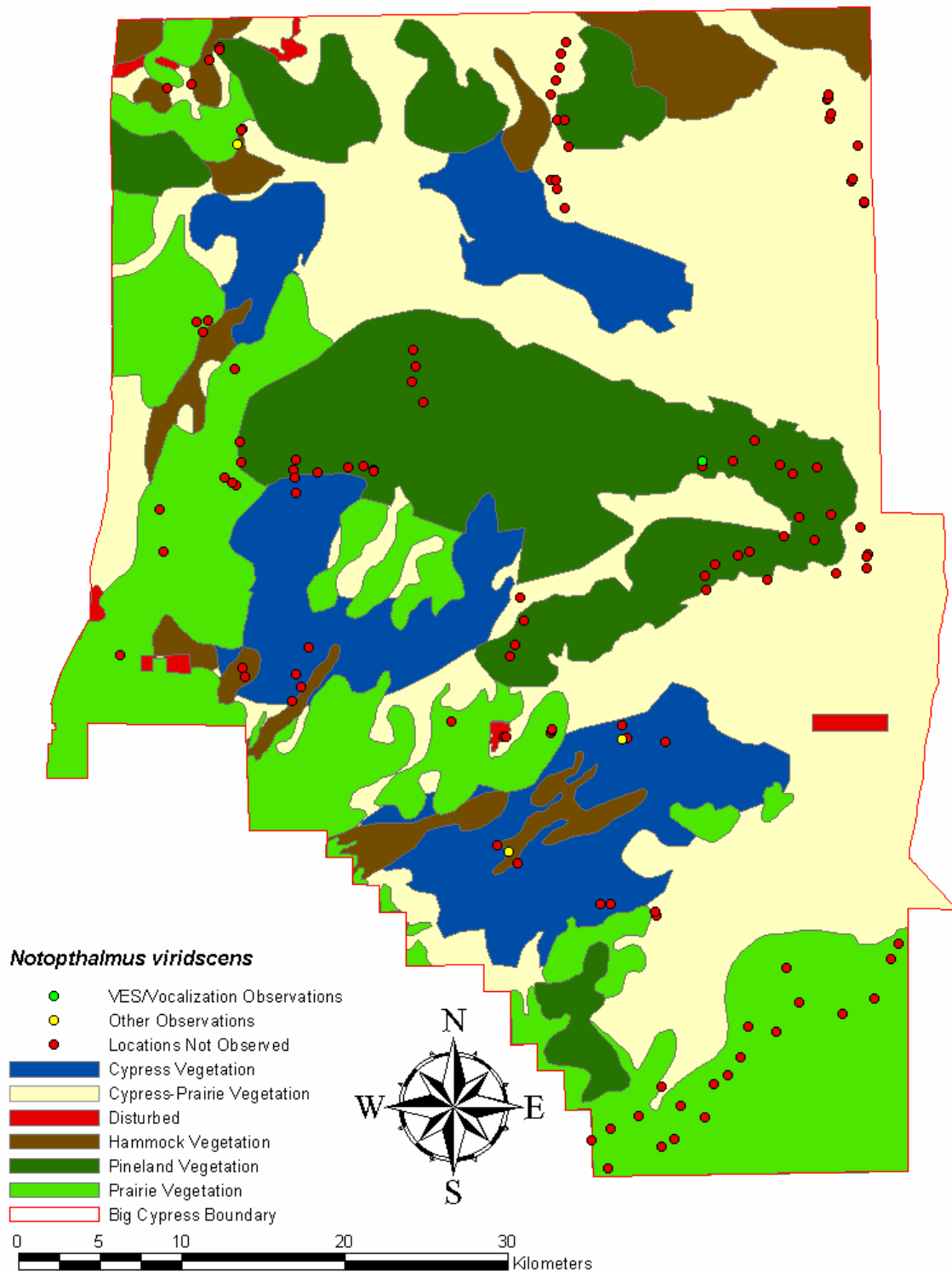
Figure 21: *Notophthalmus viridescens* locations.
Map of all locations at which *Notophthalmus viridescens* were observed in Big Cypress National Preserve
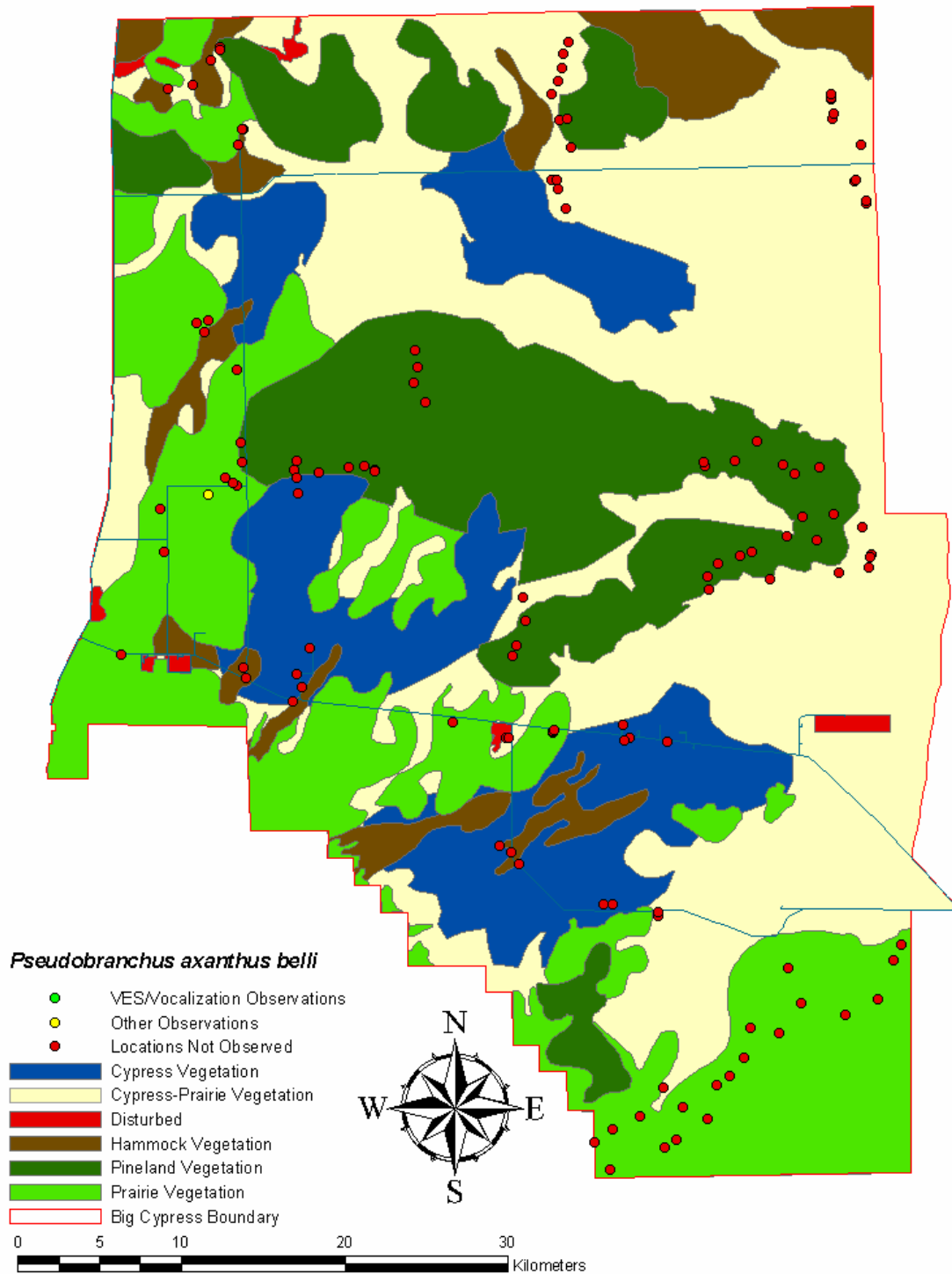
Figure 22: *Pseudobranchus axanthus belli* locations.
Map of all locations at which *Pseudobranchus axanthus belli* were observed in Big Cypress National Preserve
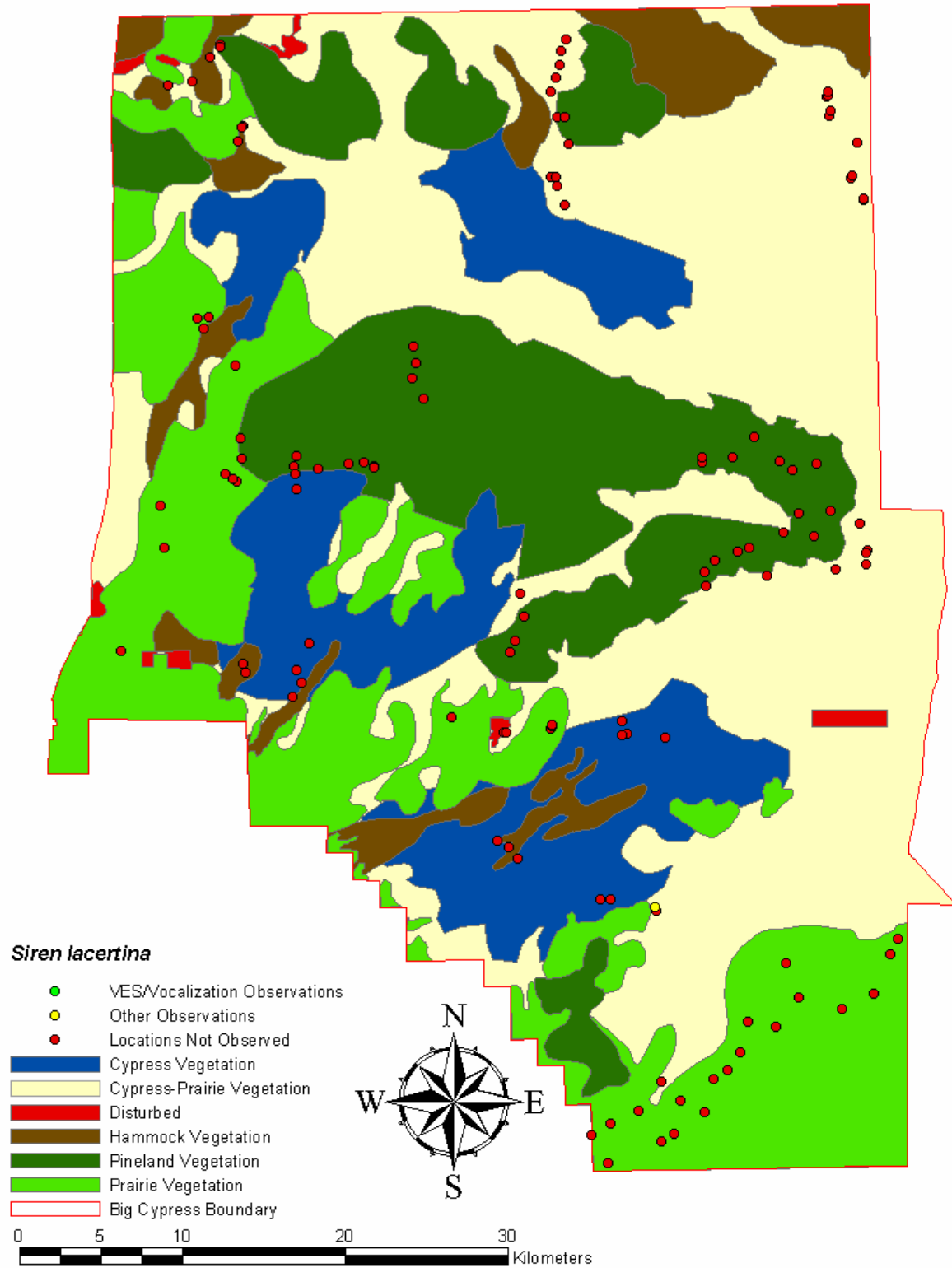
Figure 23: *Siren lacertina* locations.
Map of all locations at which *Siren lacertina* were observed in Big Cypress National Preserve
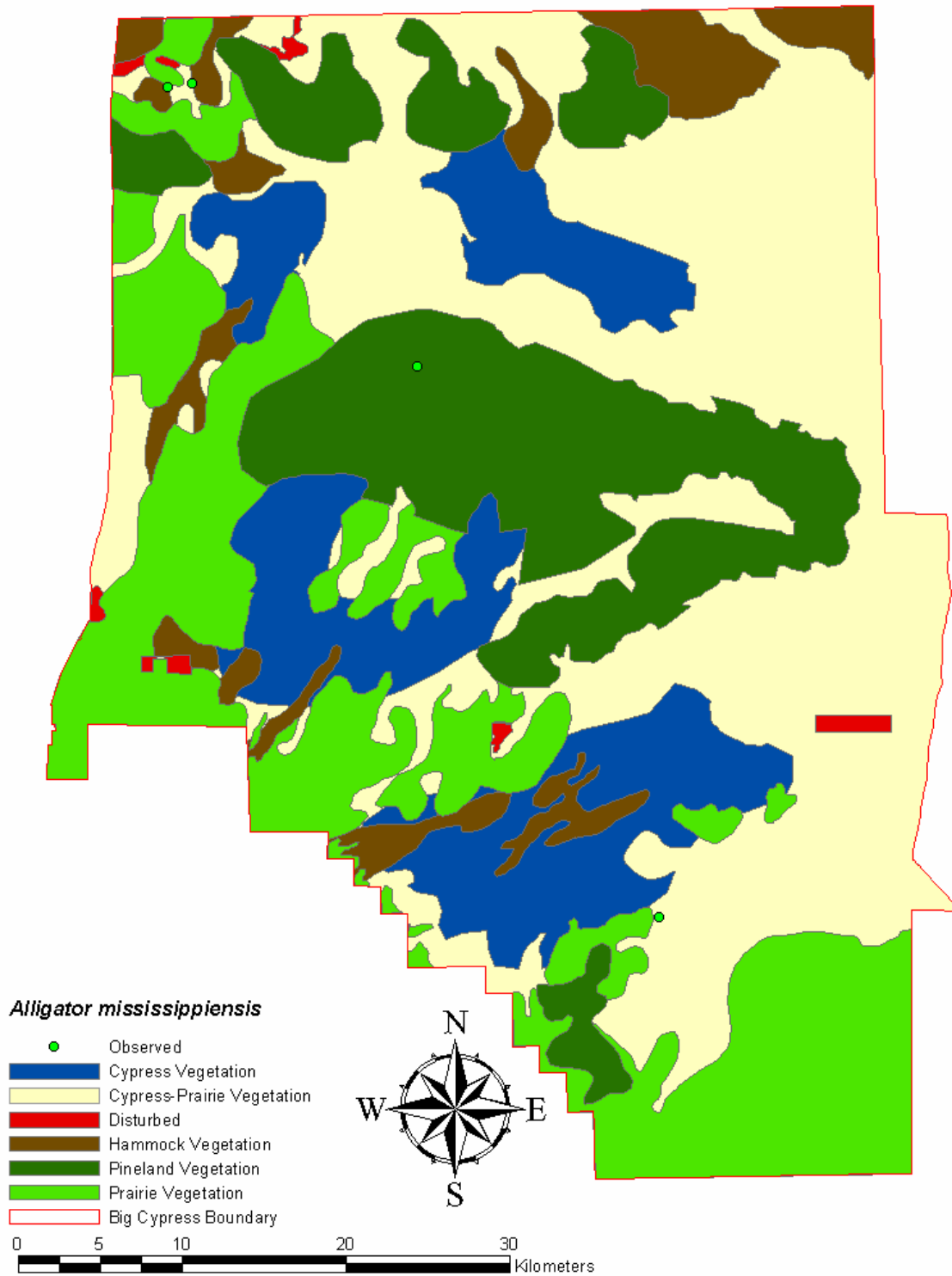
Figure 24: *Alligator mississippiensis* locations.
Map of all locations at which *Alligator mississippiensis* were observed in Big Cypress National Preserve.
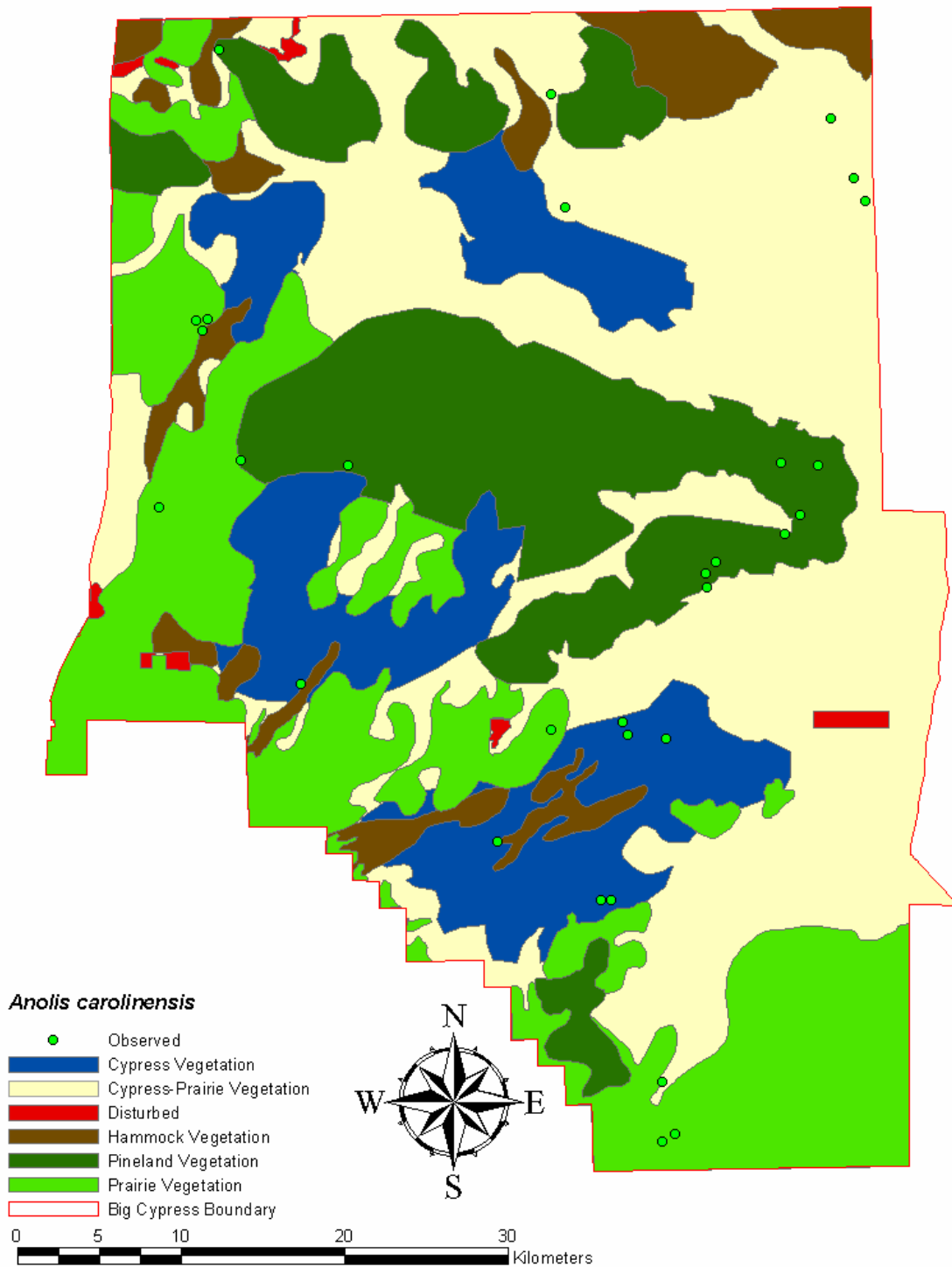
Figure 25: *Anolis carolinensis* locations.
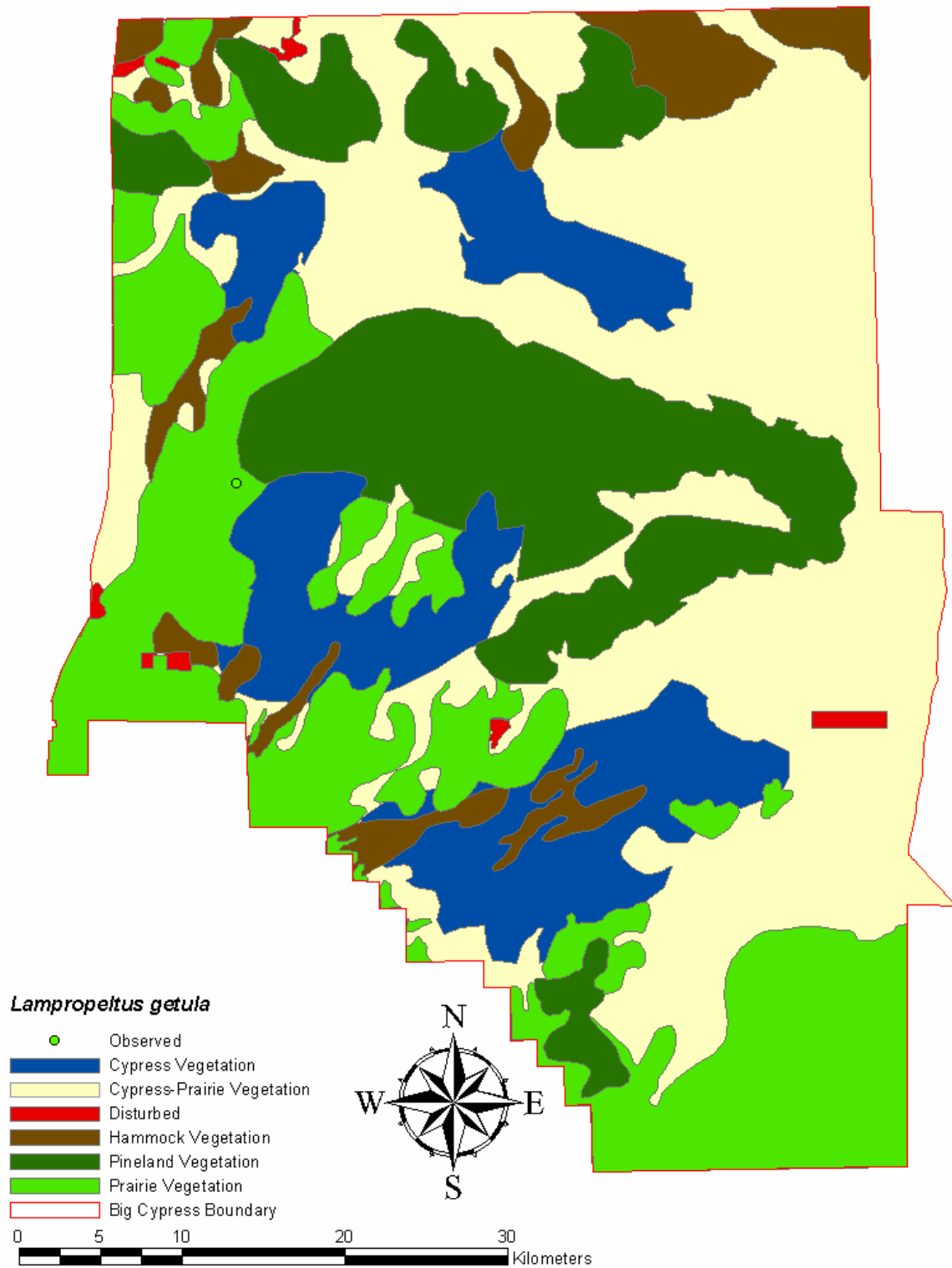Map of all locations at which *Anolis carolinensis* were observed in Big Cypress National Preserve.
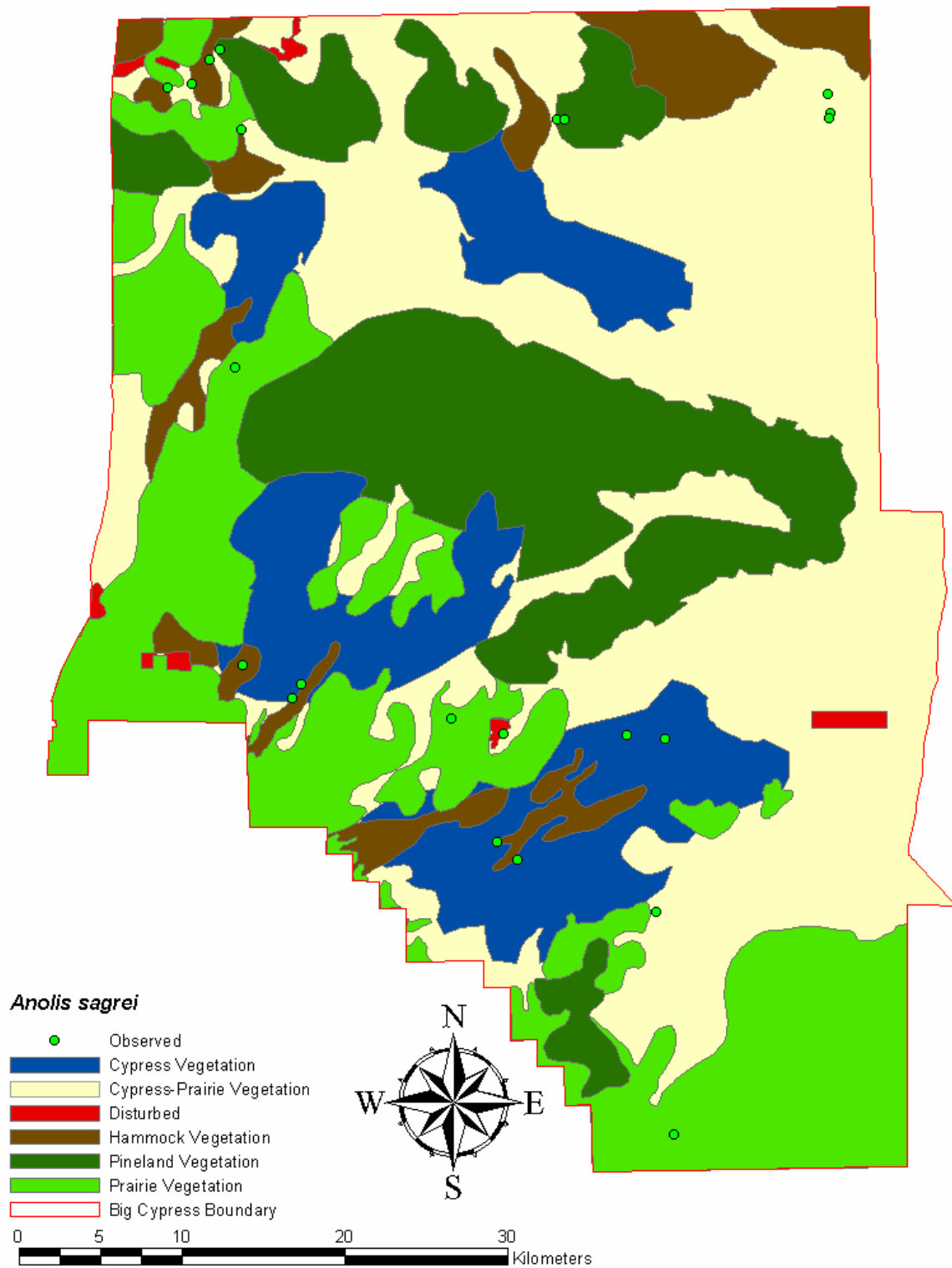
Figure 26: *Anolis sagrei* locations.
Map of all locations at which *Anolis sagrei* were observed in Big Cypress National Preserve.
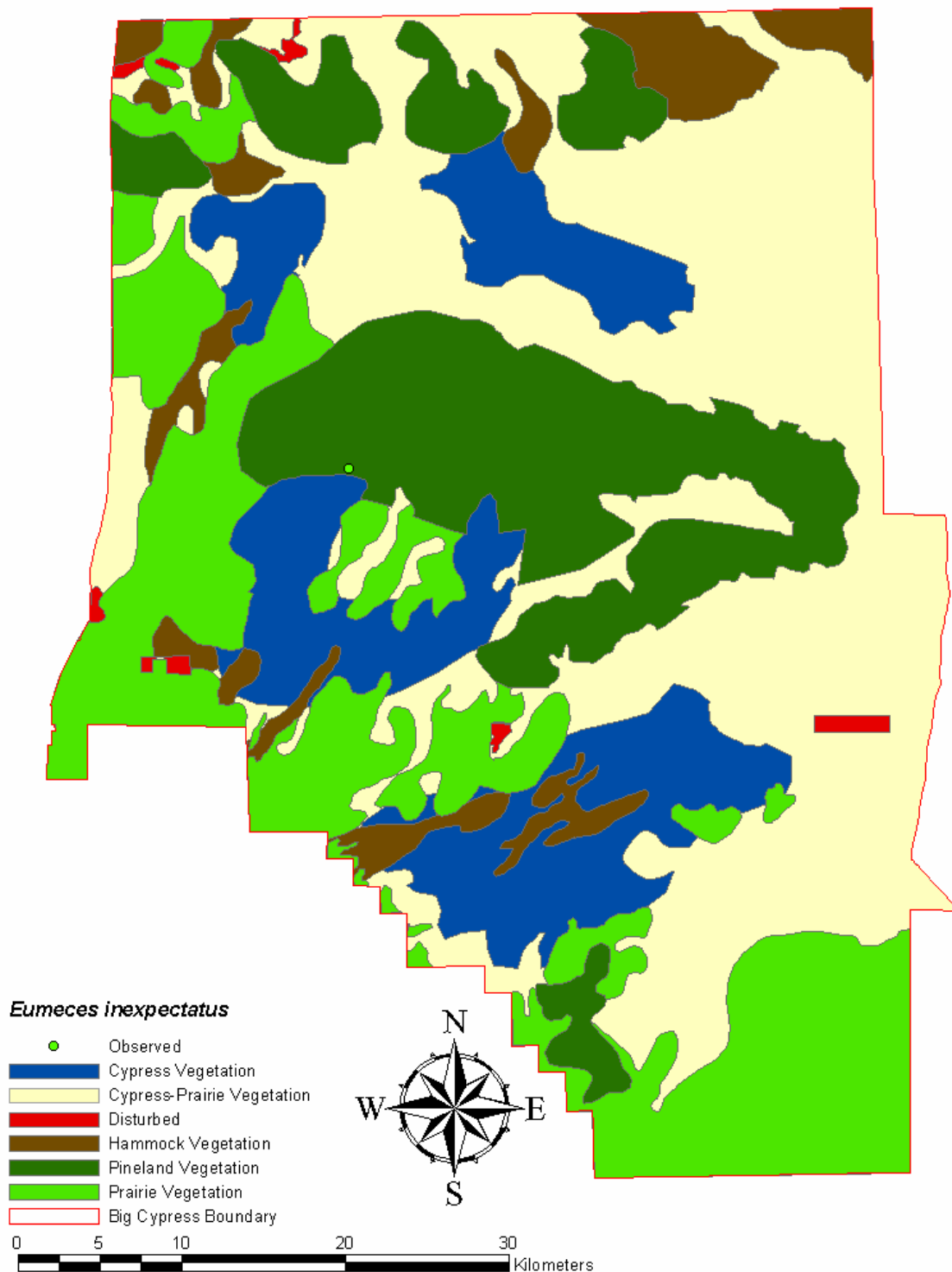
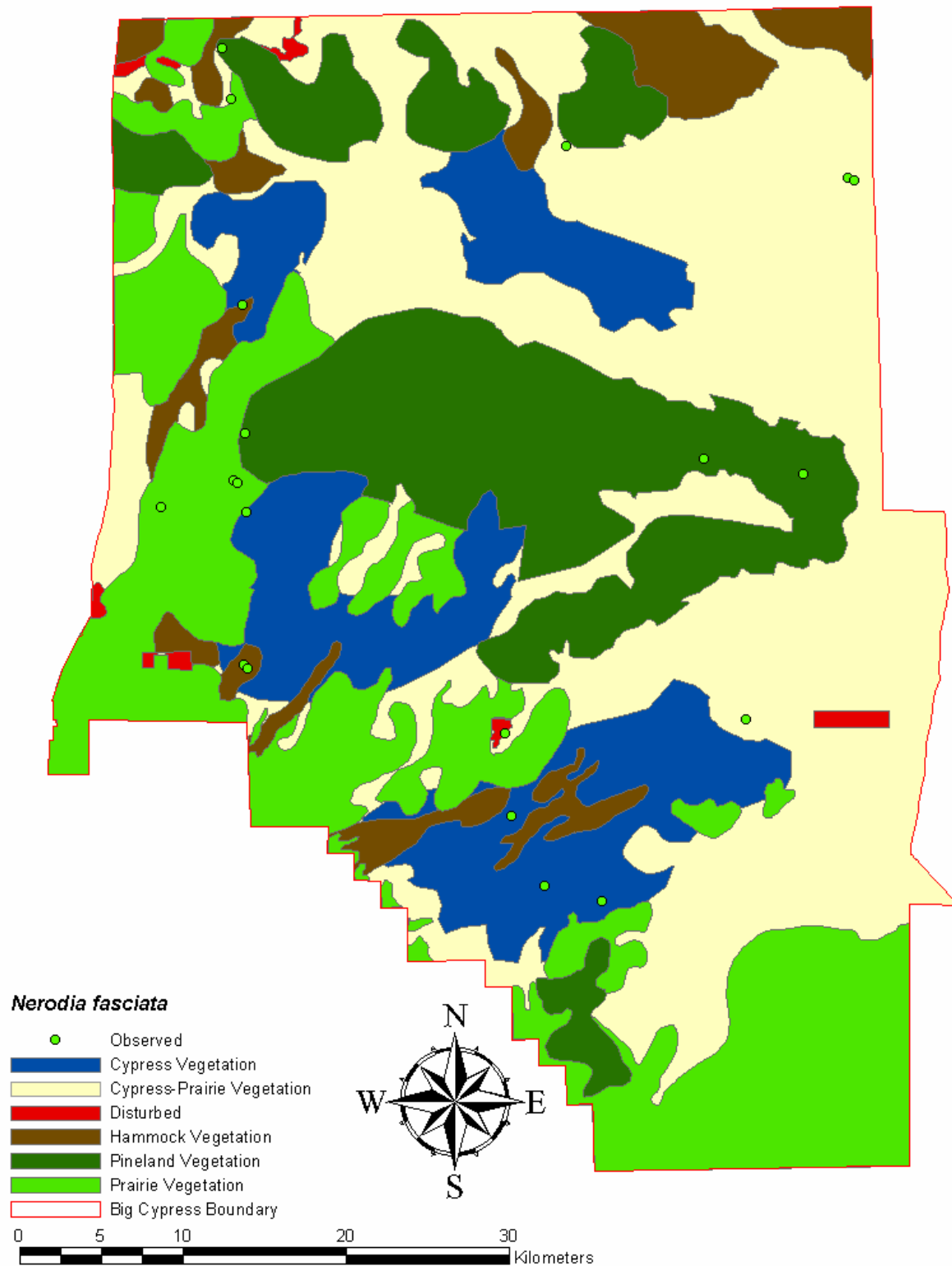Figure 27: *Eumeces inexpectatus* locations.
Map of all locations at which *Eumeces inexpectatus* were observed in Big Cypress National Preserve.
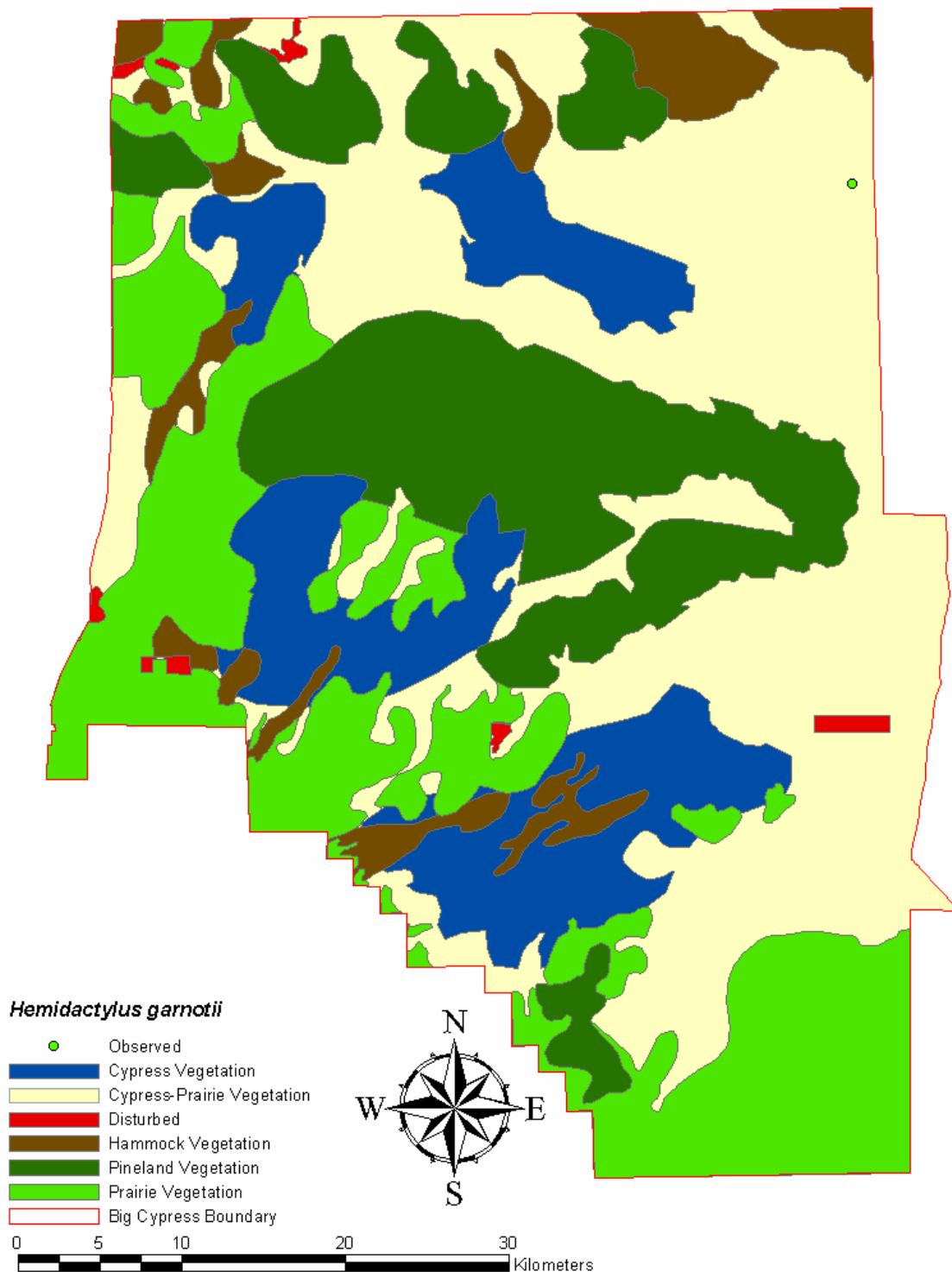
Figure 28: *Hemidactylus garnotii* locations.
Map of all locations at which *Hemidactylus garnotii* were observed in Big Cypress National Preserve.
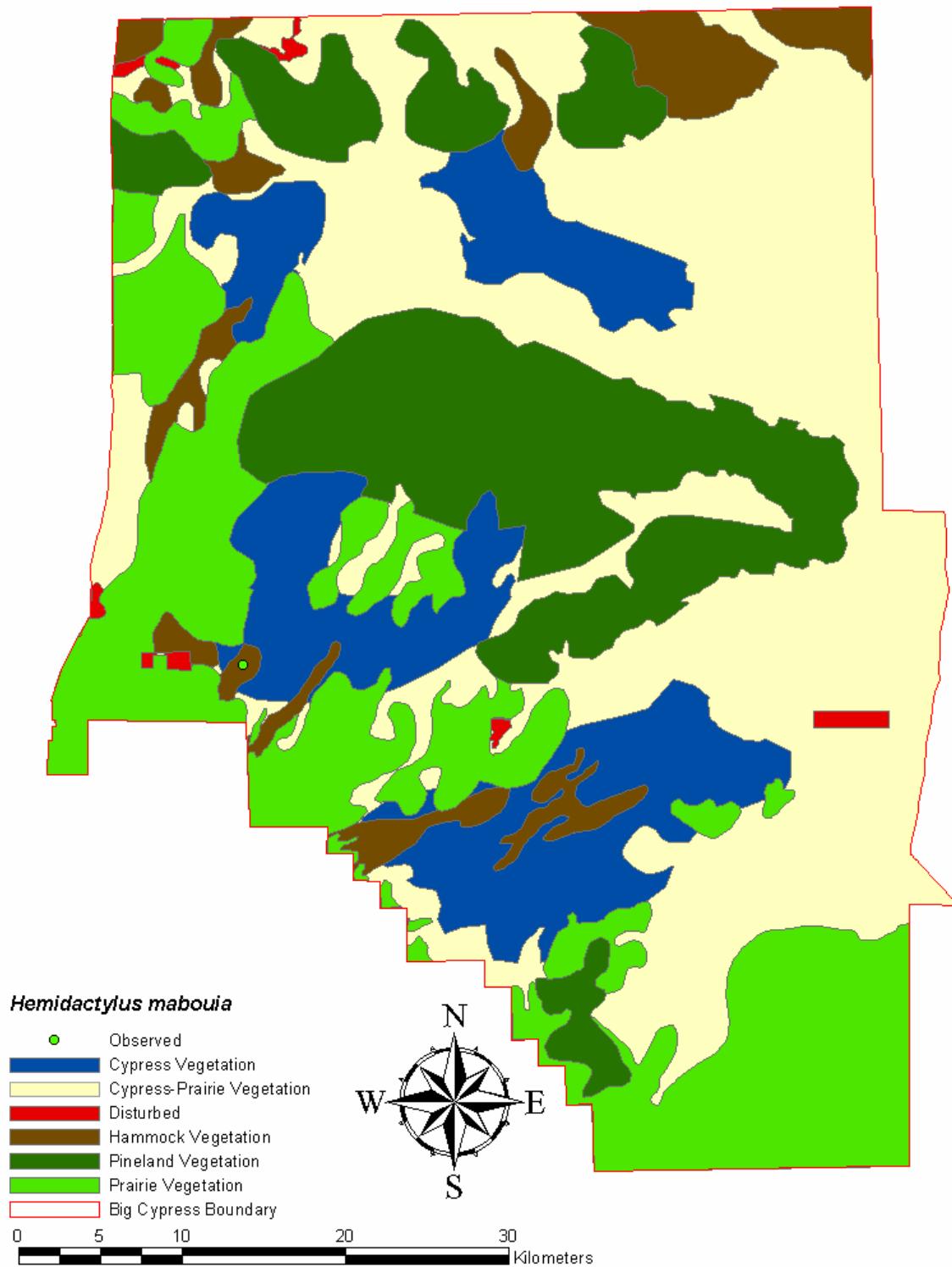
Figure 29: *Hemidactylus mabouia* locations.
Map of all locations at which *Hemidactylus mabouia* were observed in Big Cypress National Preserve.
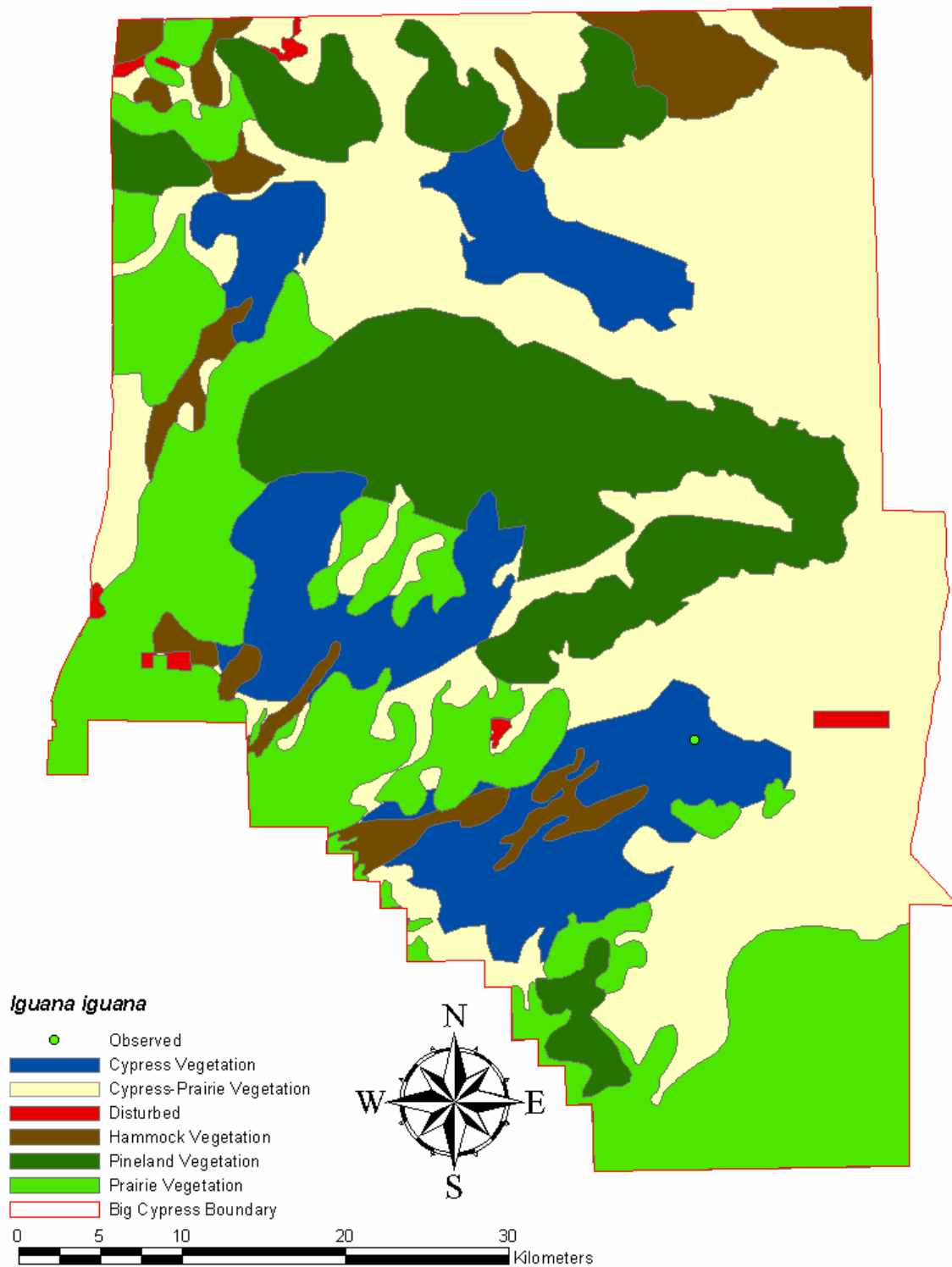
Figure 30: *Iguana iguana* locations.
Map of all locations at which *Iguana iguana* were observed in Big Cypress National Preserve.

**Ophiosaurus compressus**

- Observed
- Cypress Vegetation
- Cypress-Prairie Vegetation
- Disturbed
- Hammock Vegetation
- Pineland Vegetation
- Prairie Vegetation
- Big Cypress Boundary

Figure 31: *Ophisaurus compressus* locations.
Map of all locations at which *Ophisaurus compressus* were observed in Big Cypress National Preserve.

Figure 32: *Scincella lateralis* locations.
Map of all locations at which *Scincella lateralis* were observed in Big Cypress National Preserve.

Figure 33: *Agkistrodon piscivorus* locations.
Map of all locations at which *Agkistrodon piscivorus* were observed in Big Cypress National Preserve.
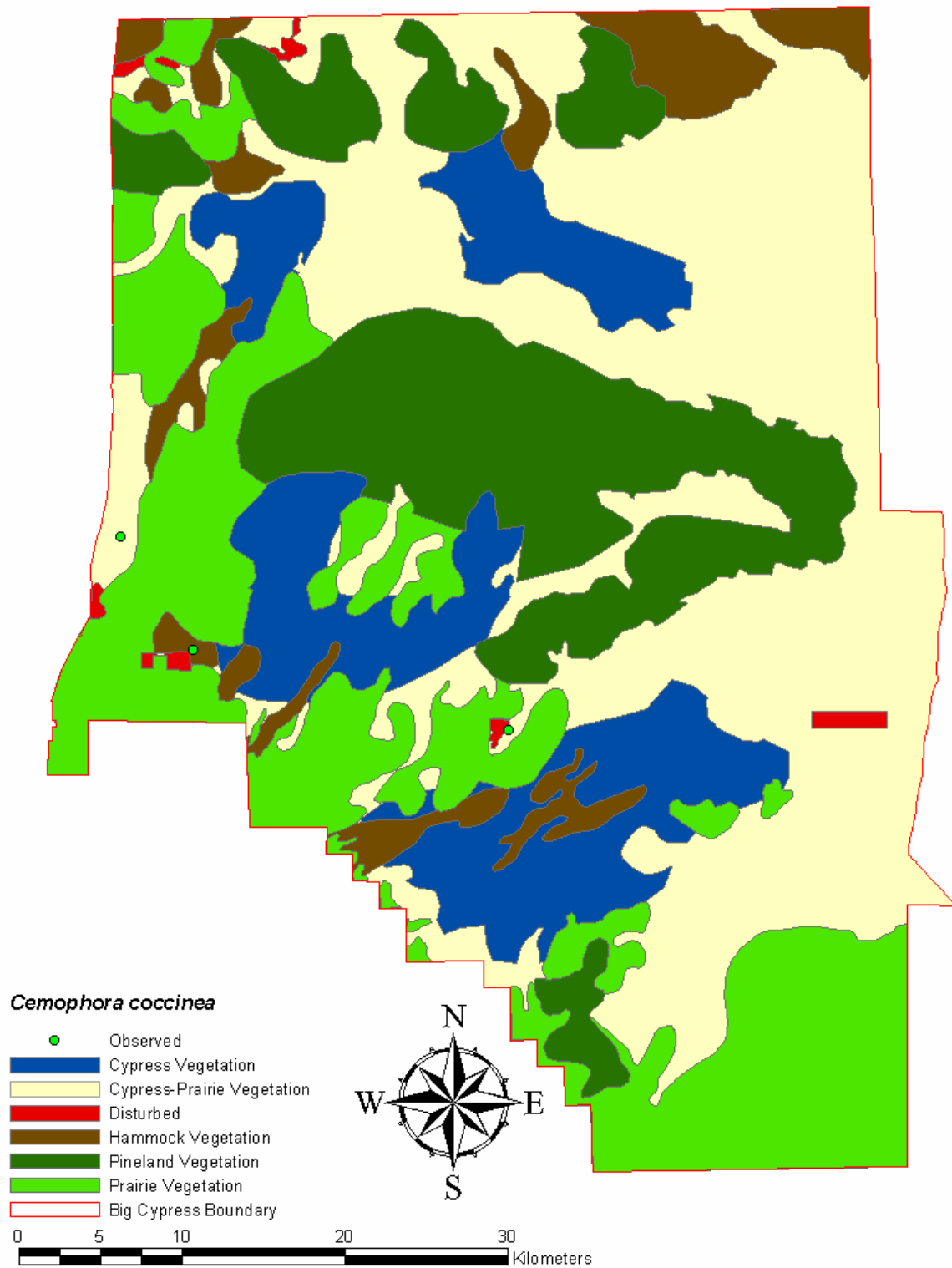
Figure 34: *Cemophora coccinea* locations.
Map of all locations at which *Cemophora coccinea* were observed in Big Cypress National Preserve.
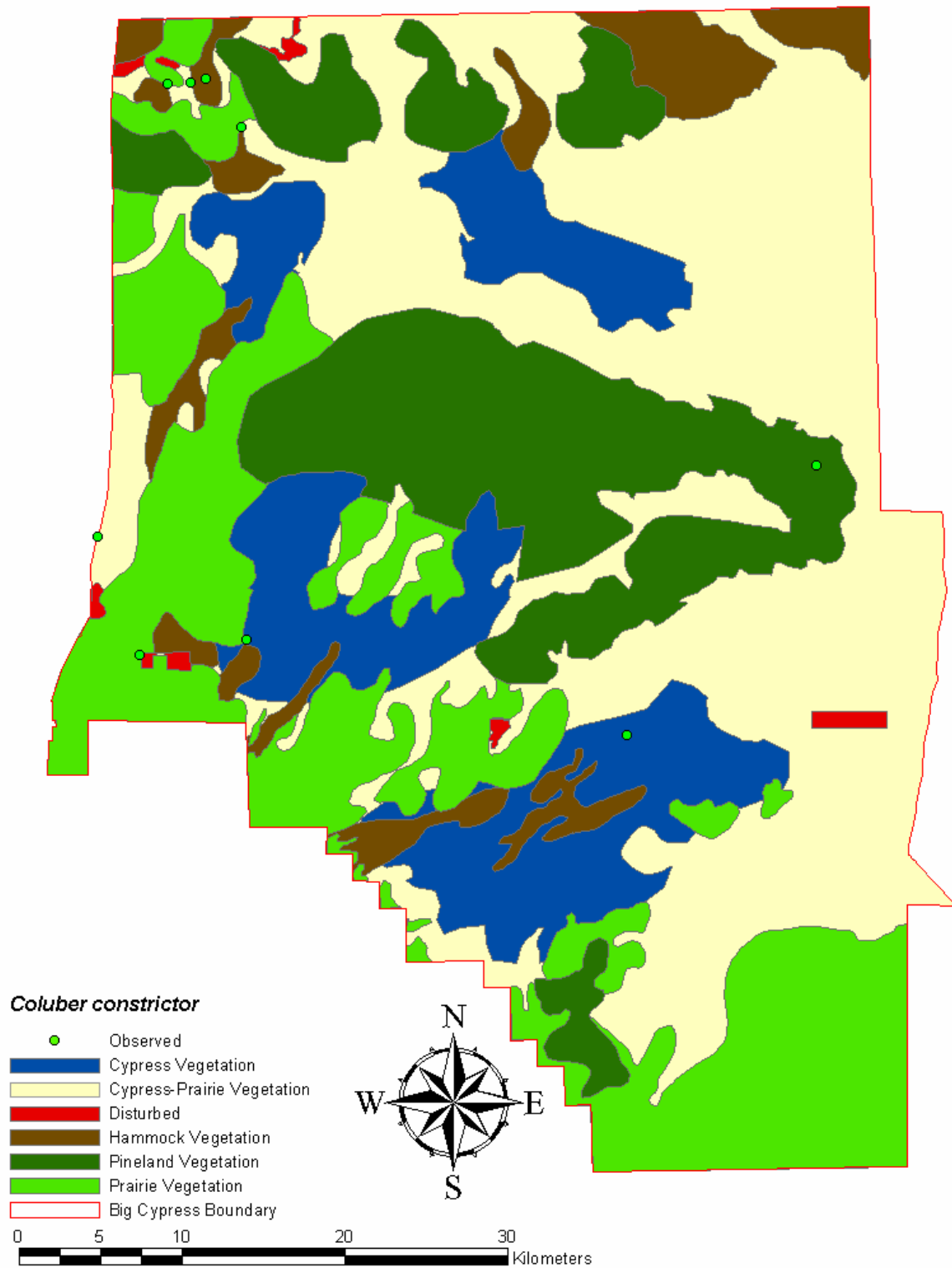
Figure 35: *Coluber constrictor* locations.
Map of all locations at which *Coluber constrictor* were observed in Big Cypress National Preserve.
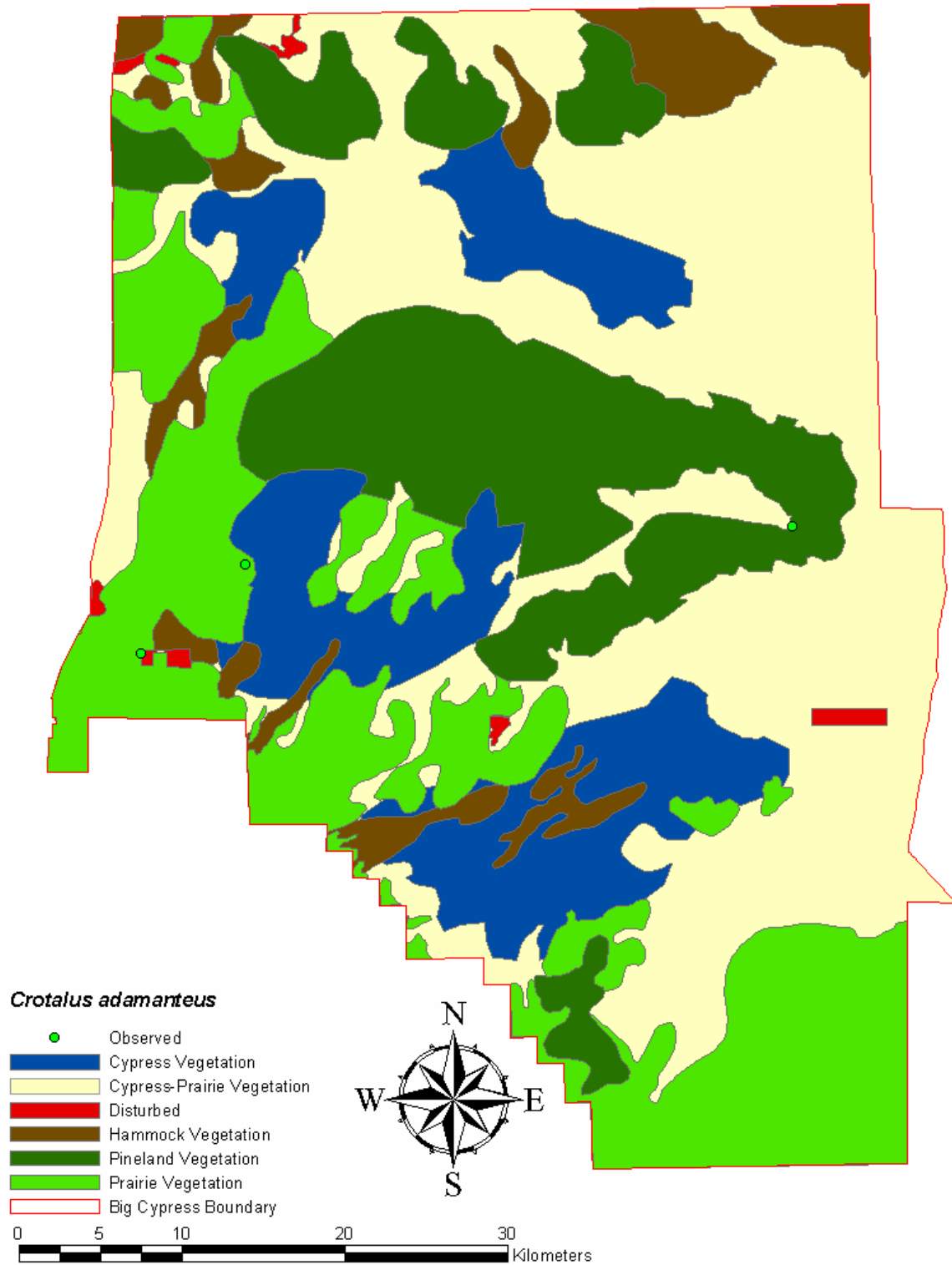
Figure 36: *Crotalus adamanteus* locations.
Map of all locations at which *Crotalus adamanteus* were observed in Big Cypress National Preserve.
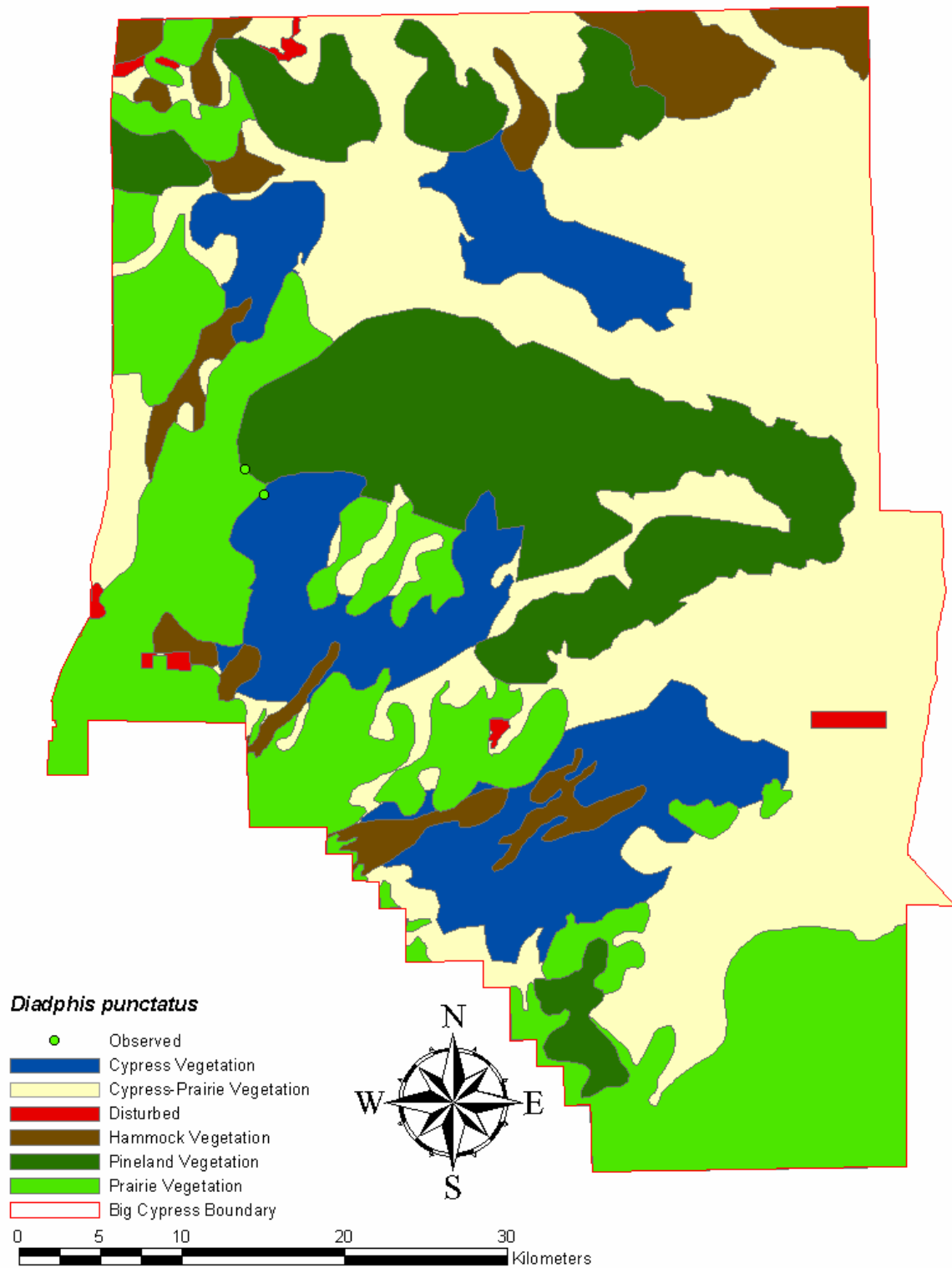
Figure 37: *Diadophis punctatus*.
Map of all locations at which *Diadophis punctatus* were observed in Big Cypress National Preserve.
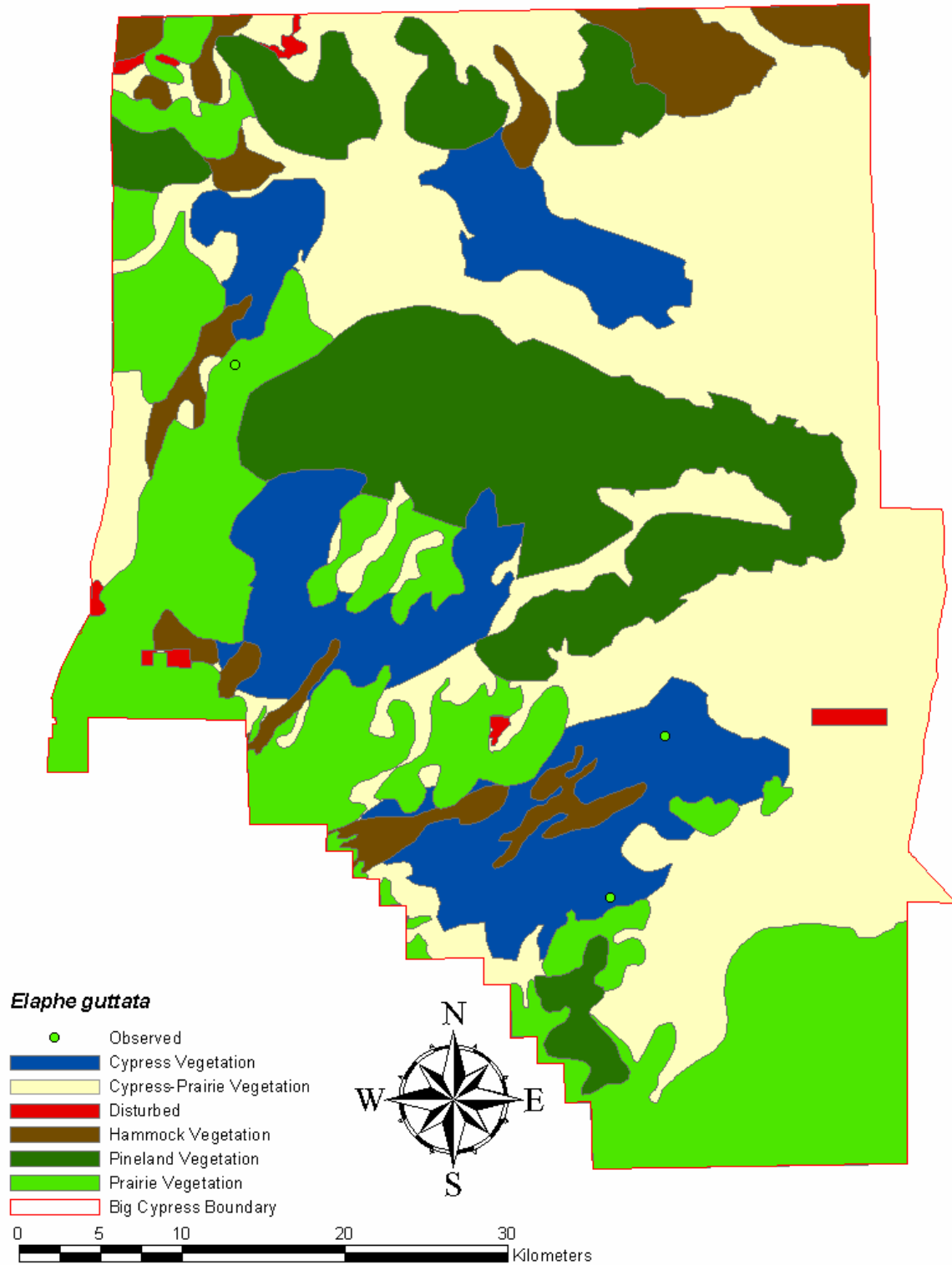
Figure 38: *Elaphe guttata* locations.
Map of all locations at which *Elaphe guttata* were observed in Big Cypress National Preserve.
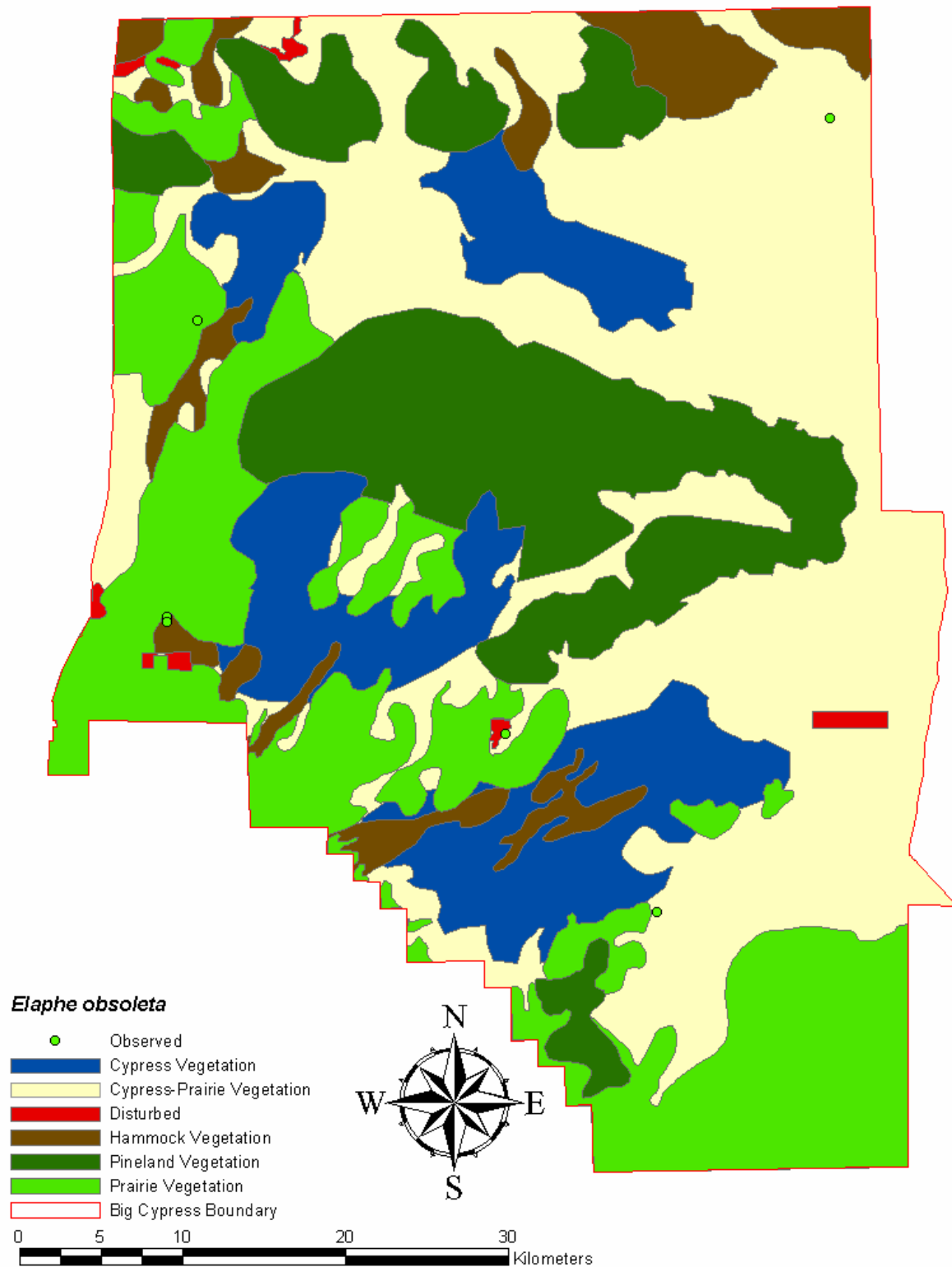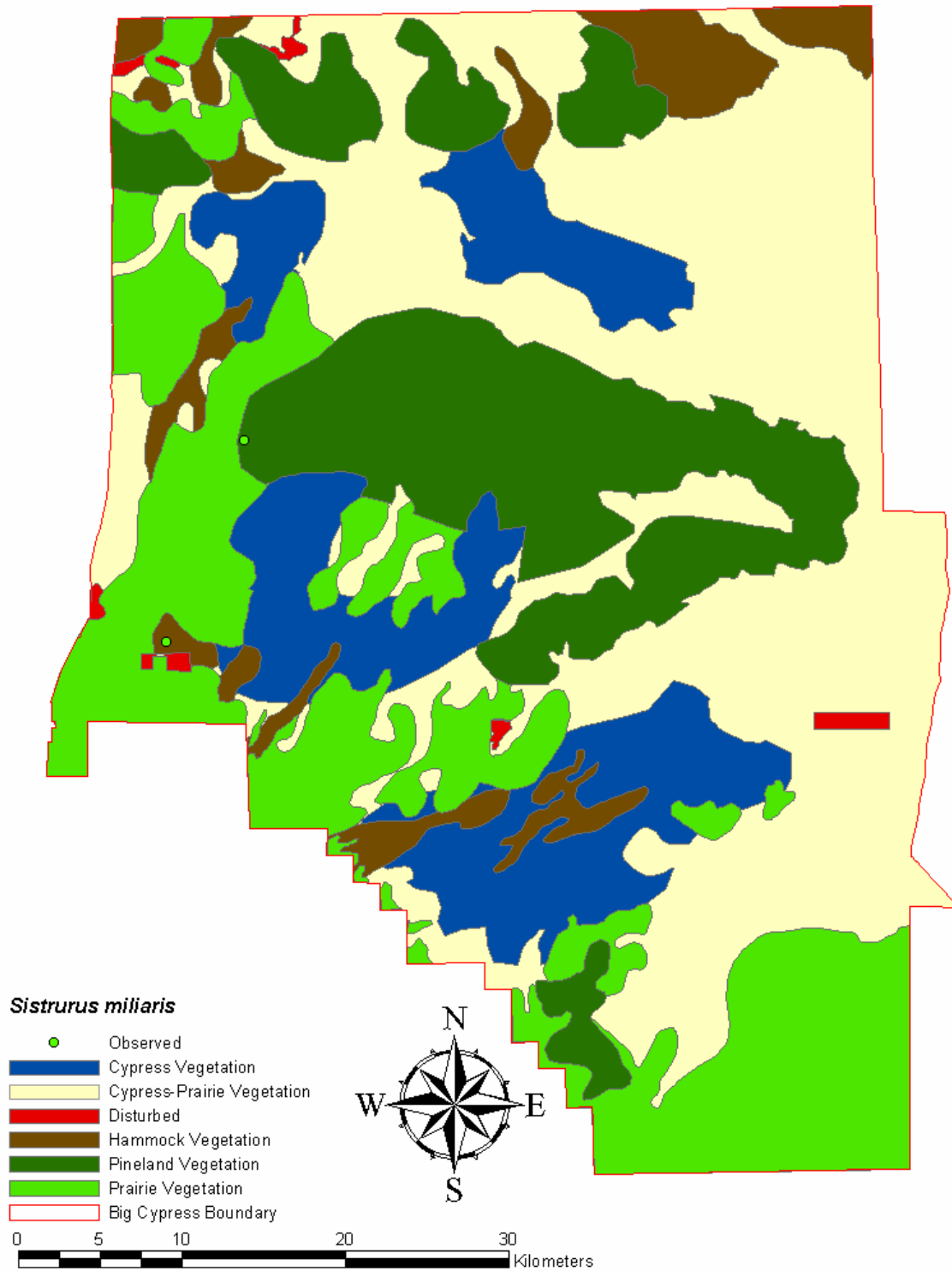
Figure 39: *Elaphe obsoleta* locations.
Map of all locations at which *Elaphe obsoleta* were observed in Big Cypress National Preserve.

Figure 40: *Lampropeltis getula* locations.
Map of all locations at which *Lampropeltis getula* were observed in Big Cypress National Preserve.
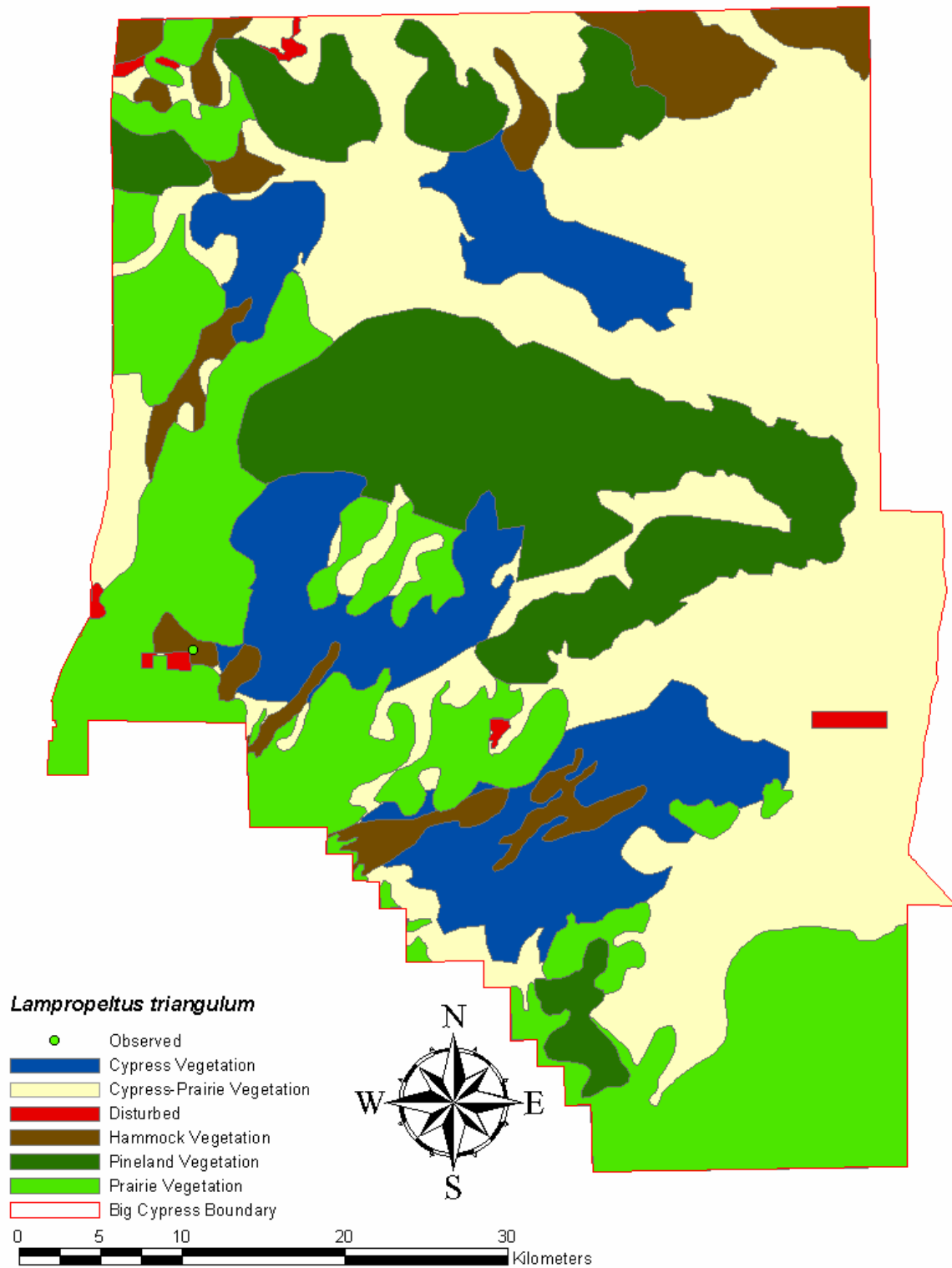
Figure 41: *Lampropeltis triangulum* locations.
Map of all locations at which *Lampropeltis trangulum* were observed in Big Cypress National Preserve.

Figure 42: *Nerodia fasciata* locations.
Map of all locations at which *Nerodia fasciata* were observed in Big Cypress National Preserve.
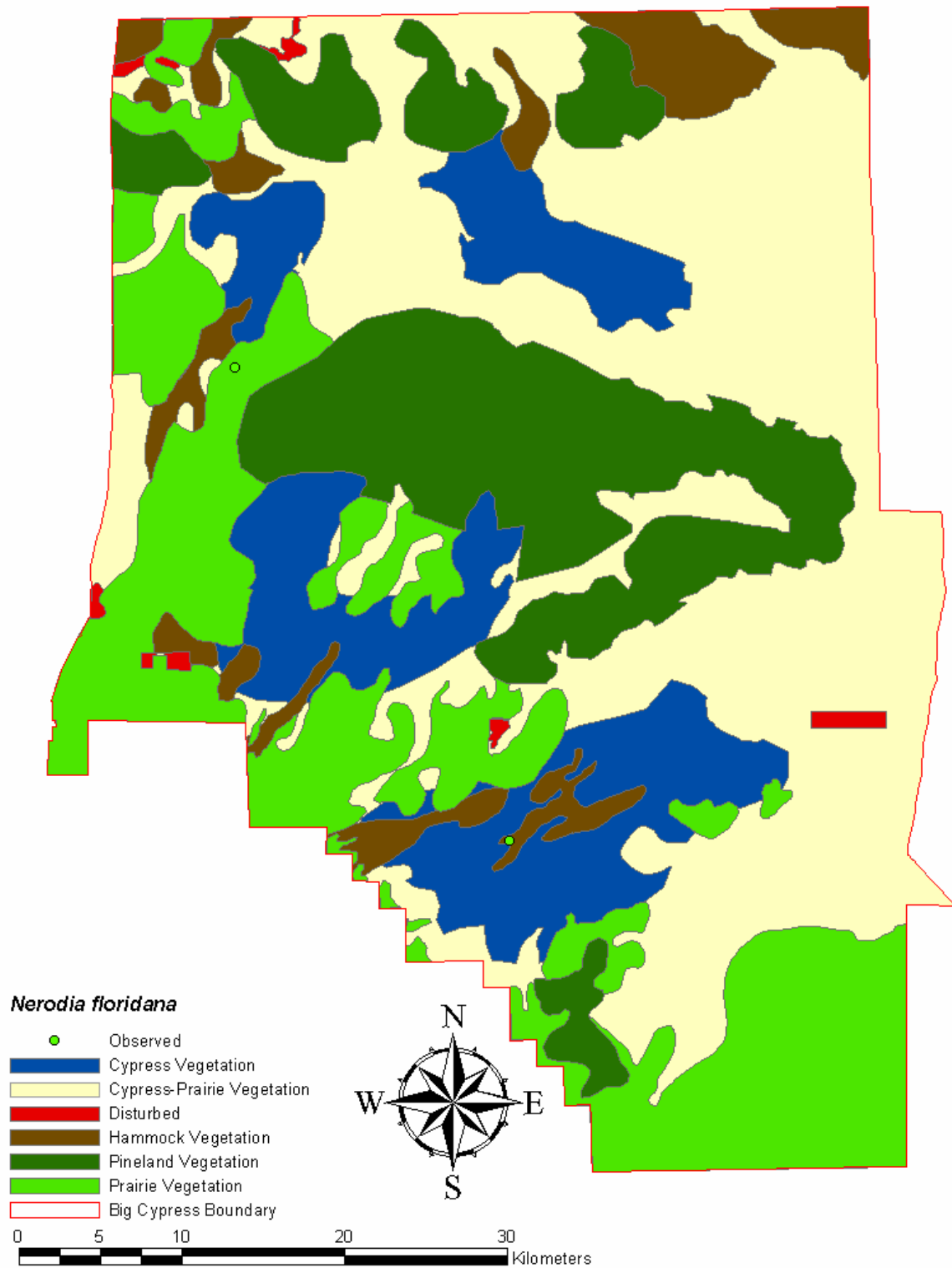
Figure 43: *Nerodia floridana* locations.
Map of all locations at which *Nerodia floridana* were observed in Big Cypress National Preserve.
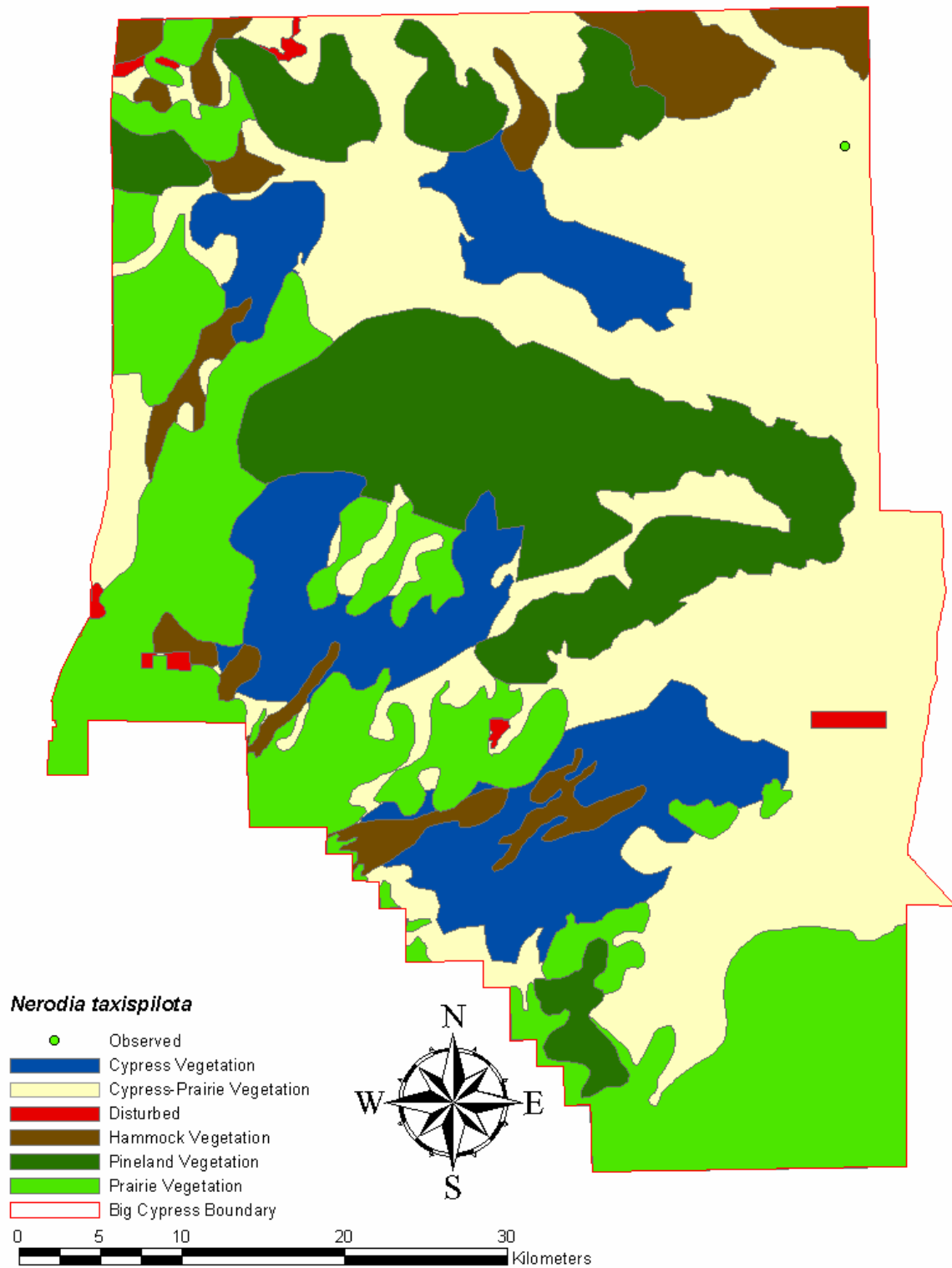
Figure 44: *Nerodia taxispilota* locations.
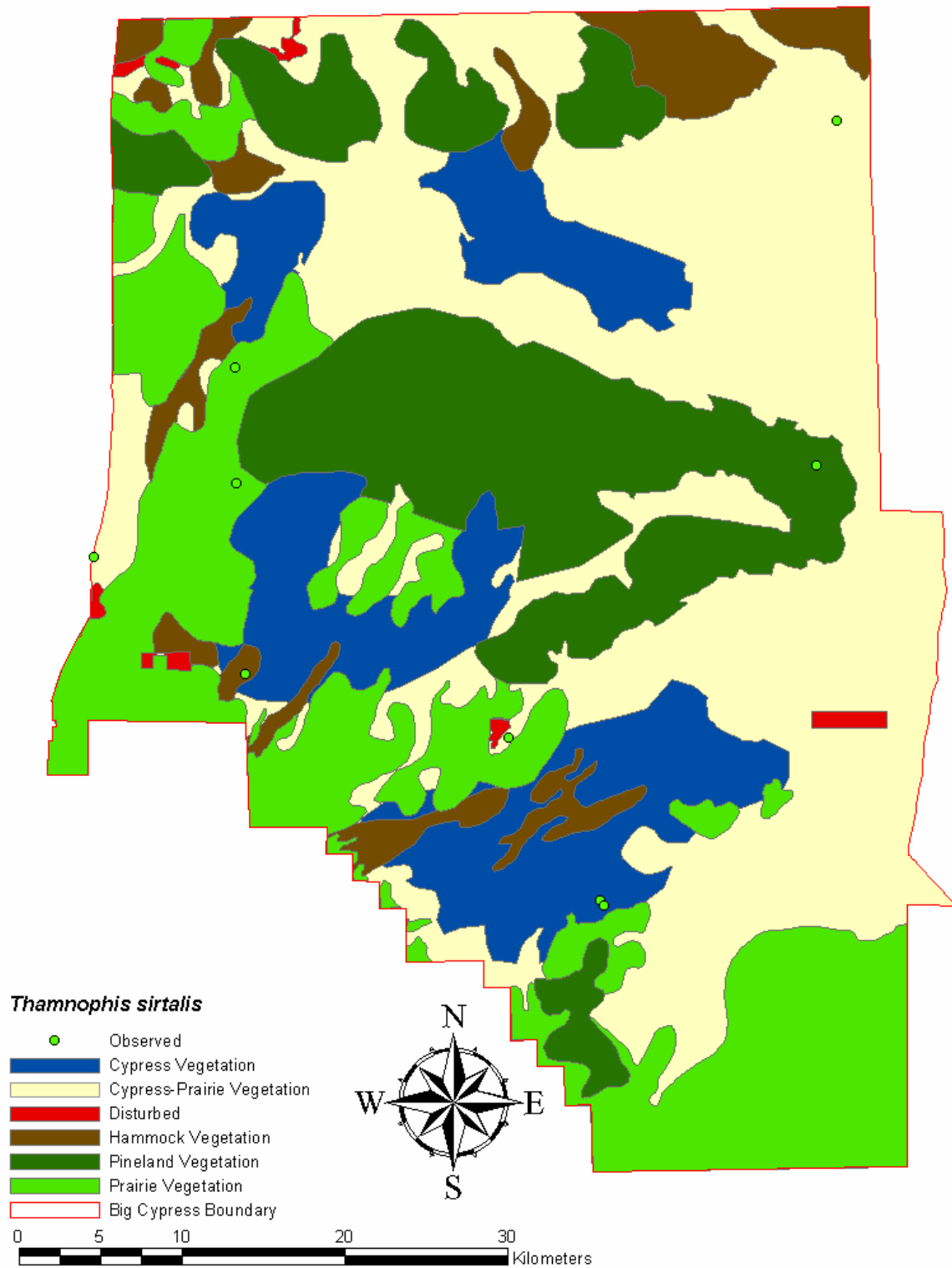Map of all locations at which *Nerodia taxispilota* were observed in Big Cypress National Preserve.
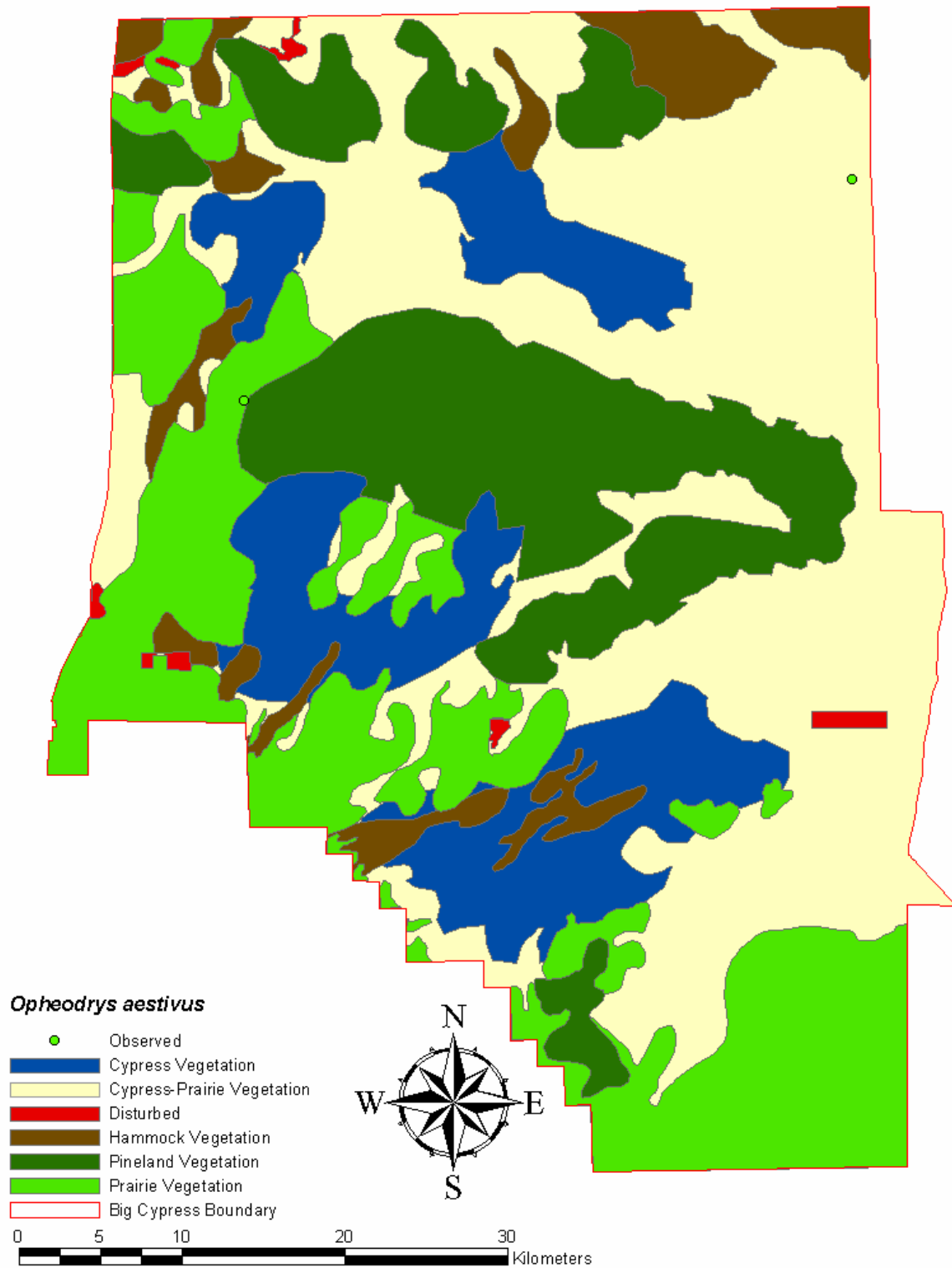
Figure 45: *Opheodrys aestivus* locations.
Map of all locations at which *Opheodrys aestivus* were observed in Big Cypress National Preserve.
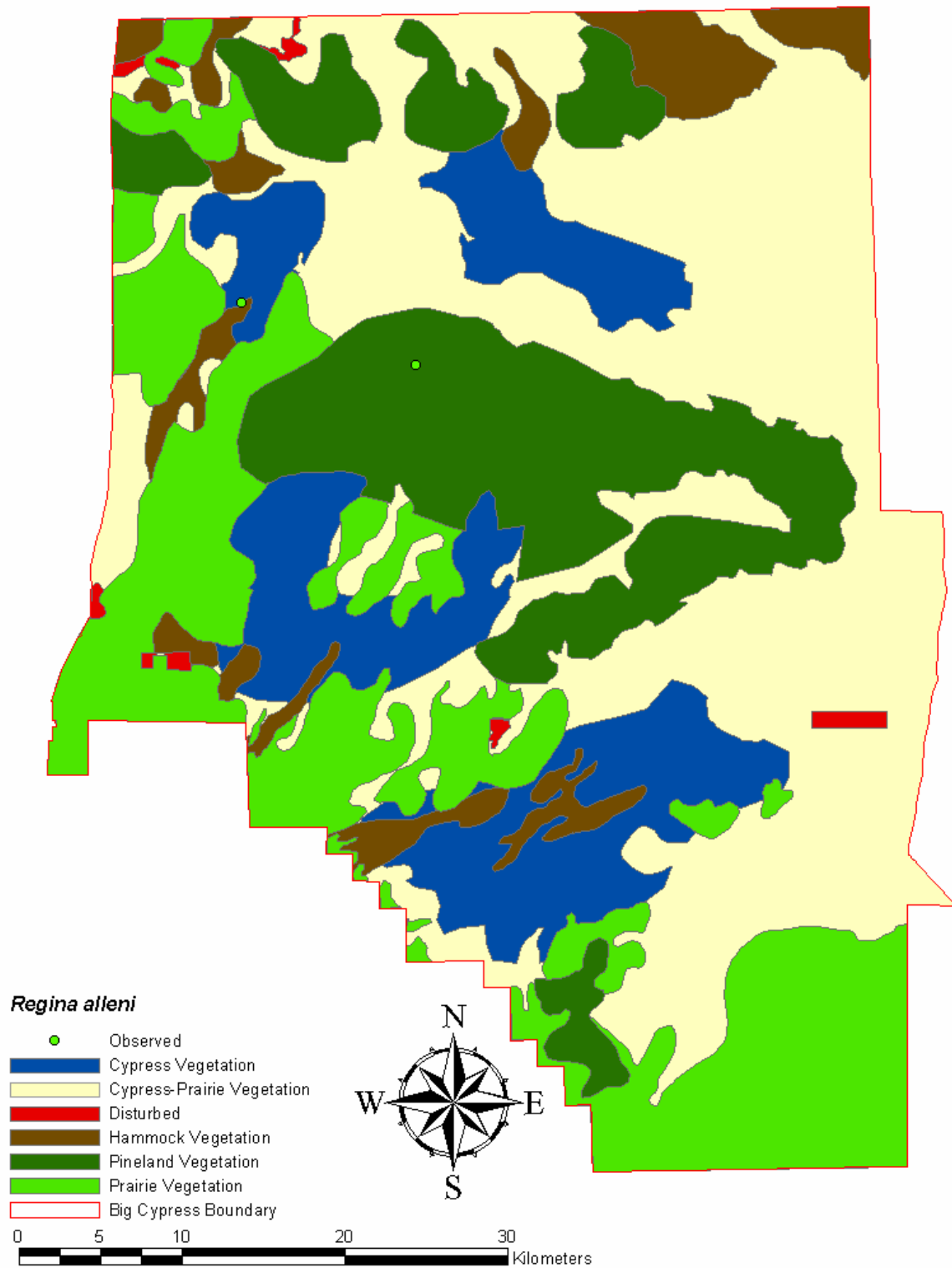
Figure 46: *Regina alleni* locations.
Map of all locations at which *Regina alleni* were observed in Big Cypress National Preserve.

Figure 47: *Sistrurus miliarius* locations.
Map of all locations at which *Sistrurus miliarius* were observed in Big Cypress National Preserve.
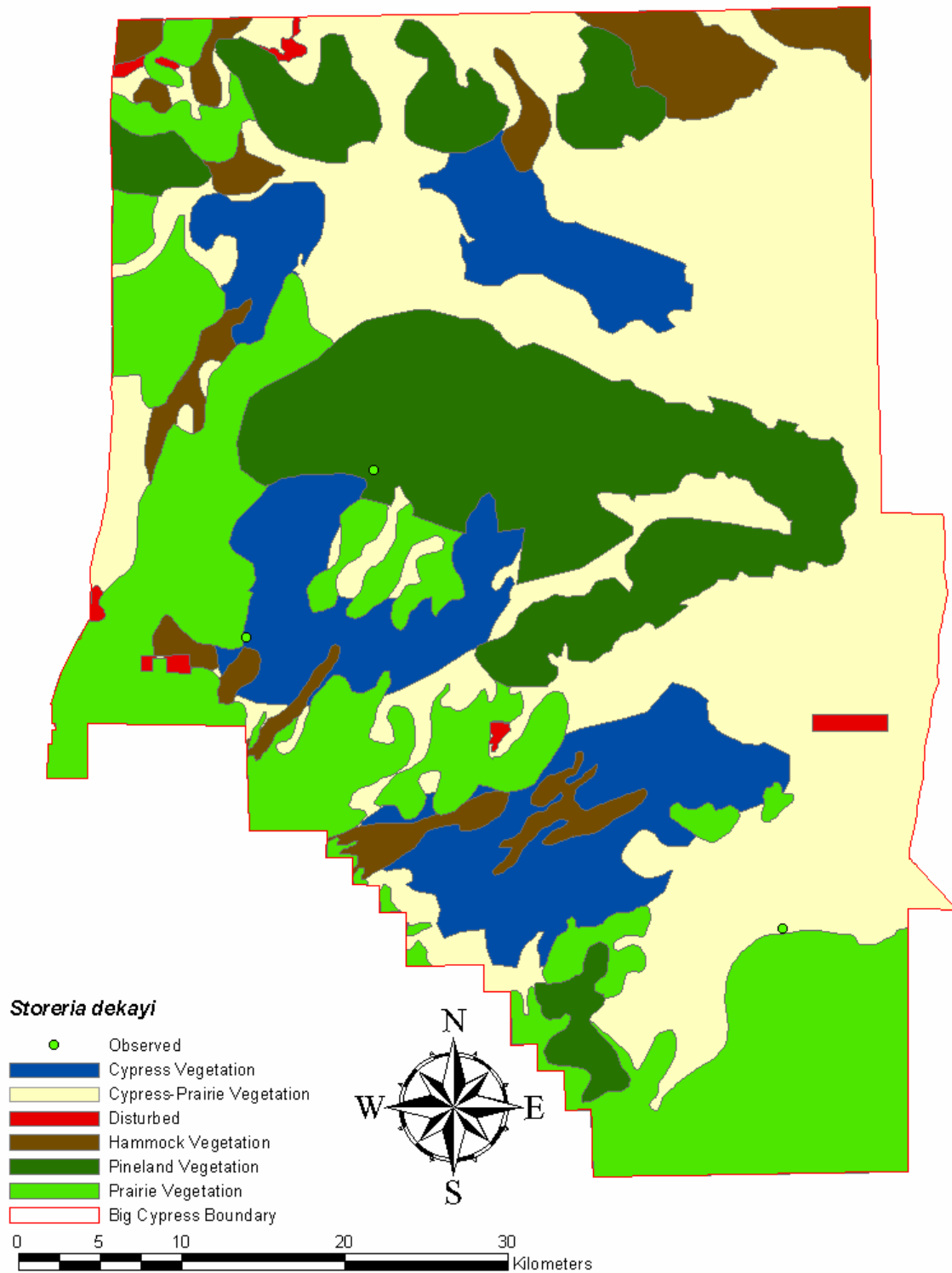
Figure 48: *Storeria dekayi* locations.
Map of all locations at which *Storeria dekayi* were observed in Everglades National Park.
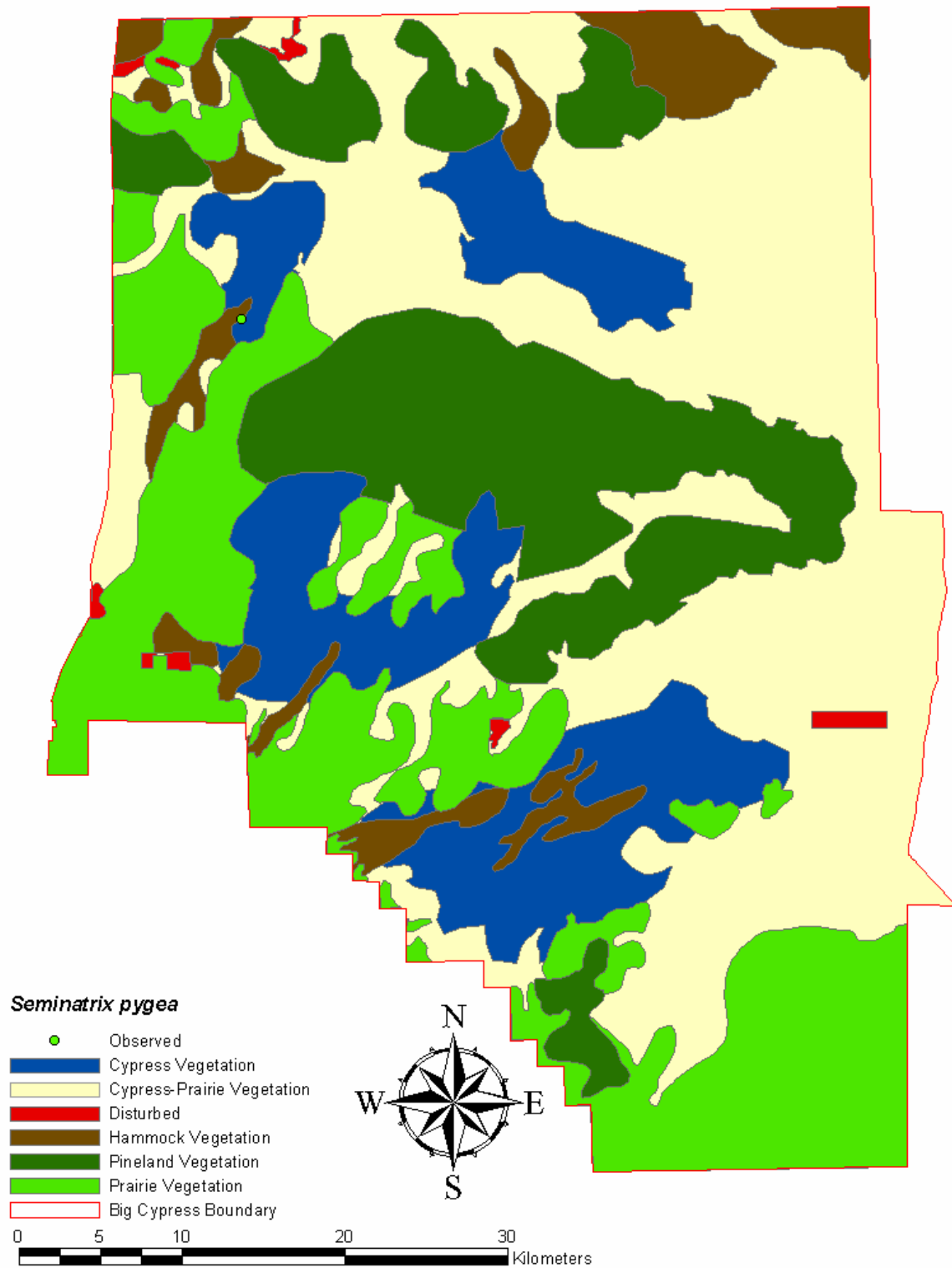
Figure 49: *Seminatrix pygea* locations.
Map of all locations at which *Seminatrix pygea* were observed in Big Cypress National Preserve.
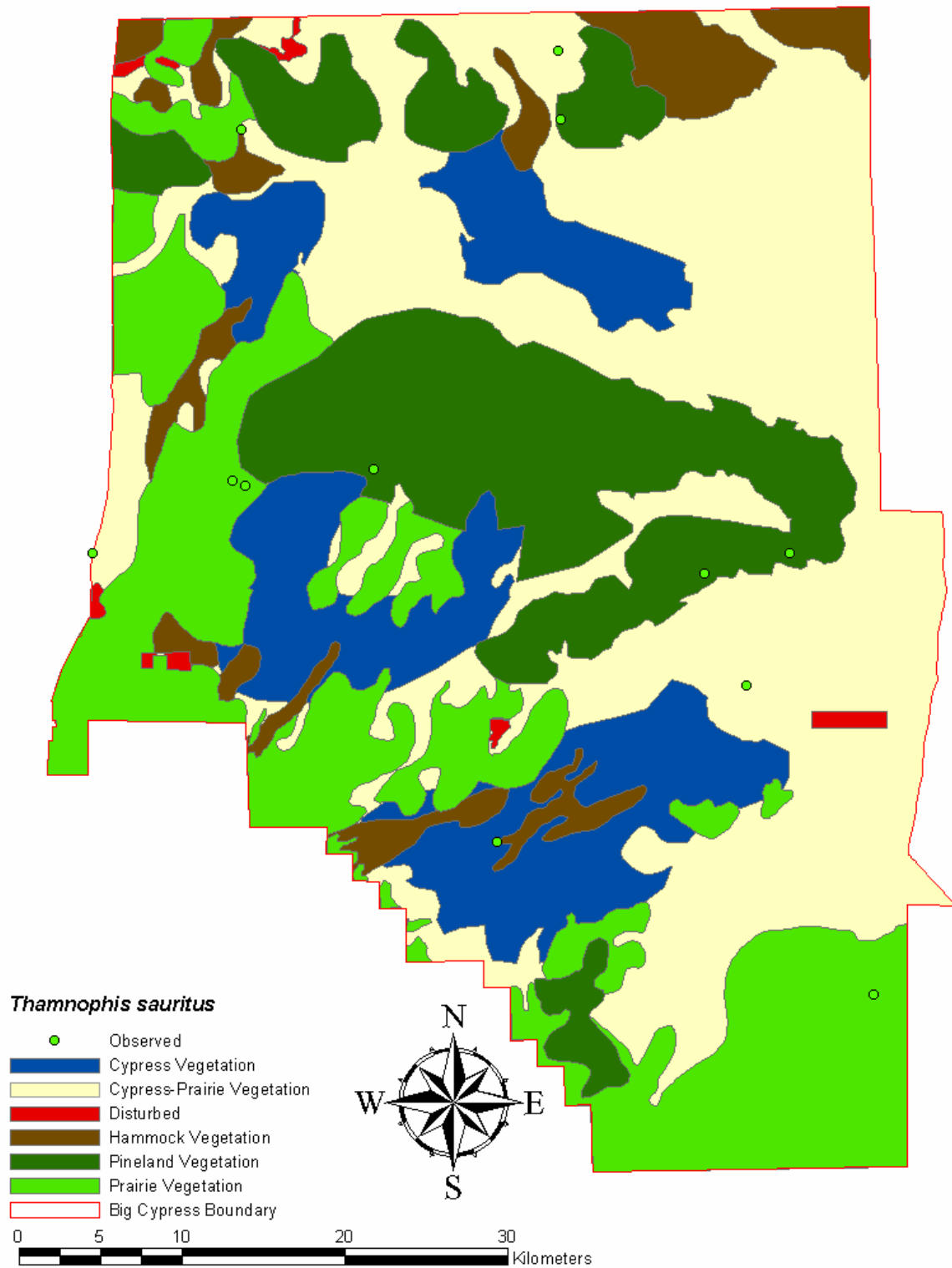
Figure 50: *Thamnophis sauritus* locations.
Map of all locations at which *Thamnophis sauritus* were observed in Big Cypress National Preserve.

Figure 51: *Thamnophis sirtalis* locations.
Map of all locations at which *Thamnophis sirtalis* were observed in Big Cypress National Preserve.
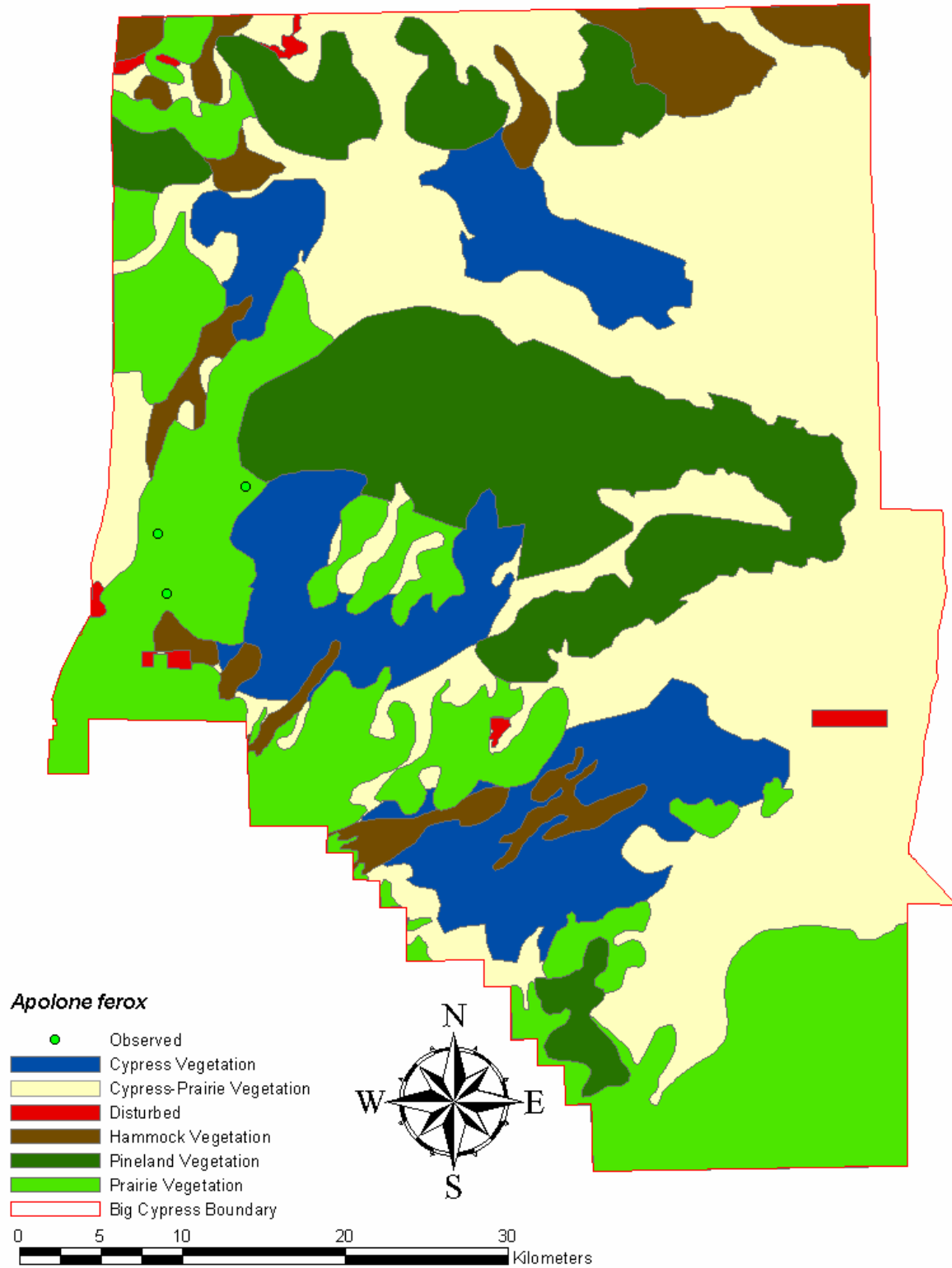
Figure 52: *Apolone ferox* locations.
Map of all locations at which *Apolone ferox* were observed in Big Cypress National Preserve.
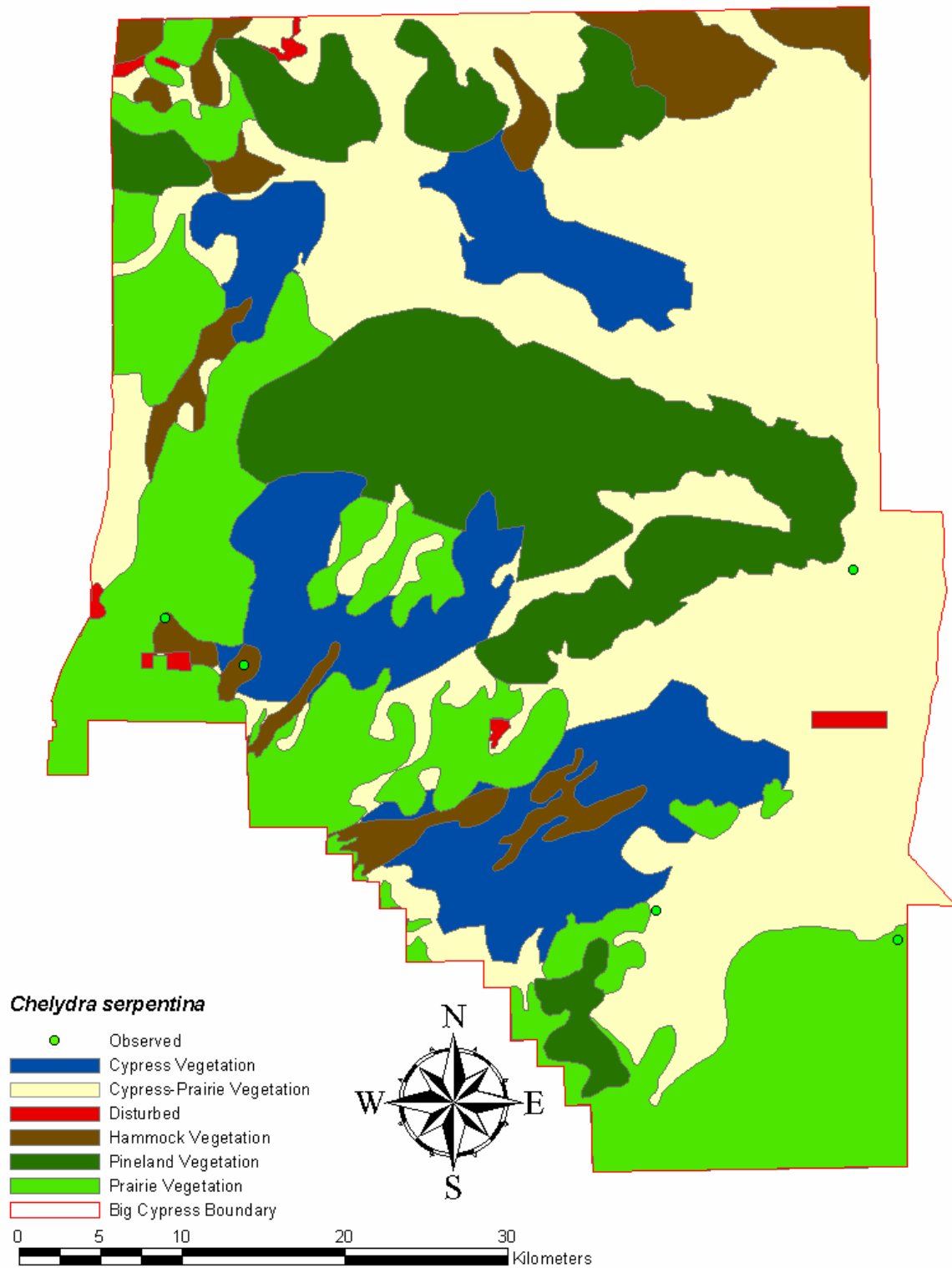
Figure 53: *Chelydra serpentina* locations.
Map of all locations at which *Chelydra serpentina* were observed in Big Cypress National Preserve.
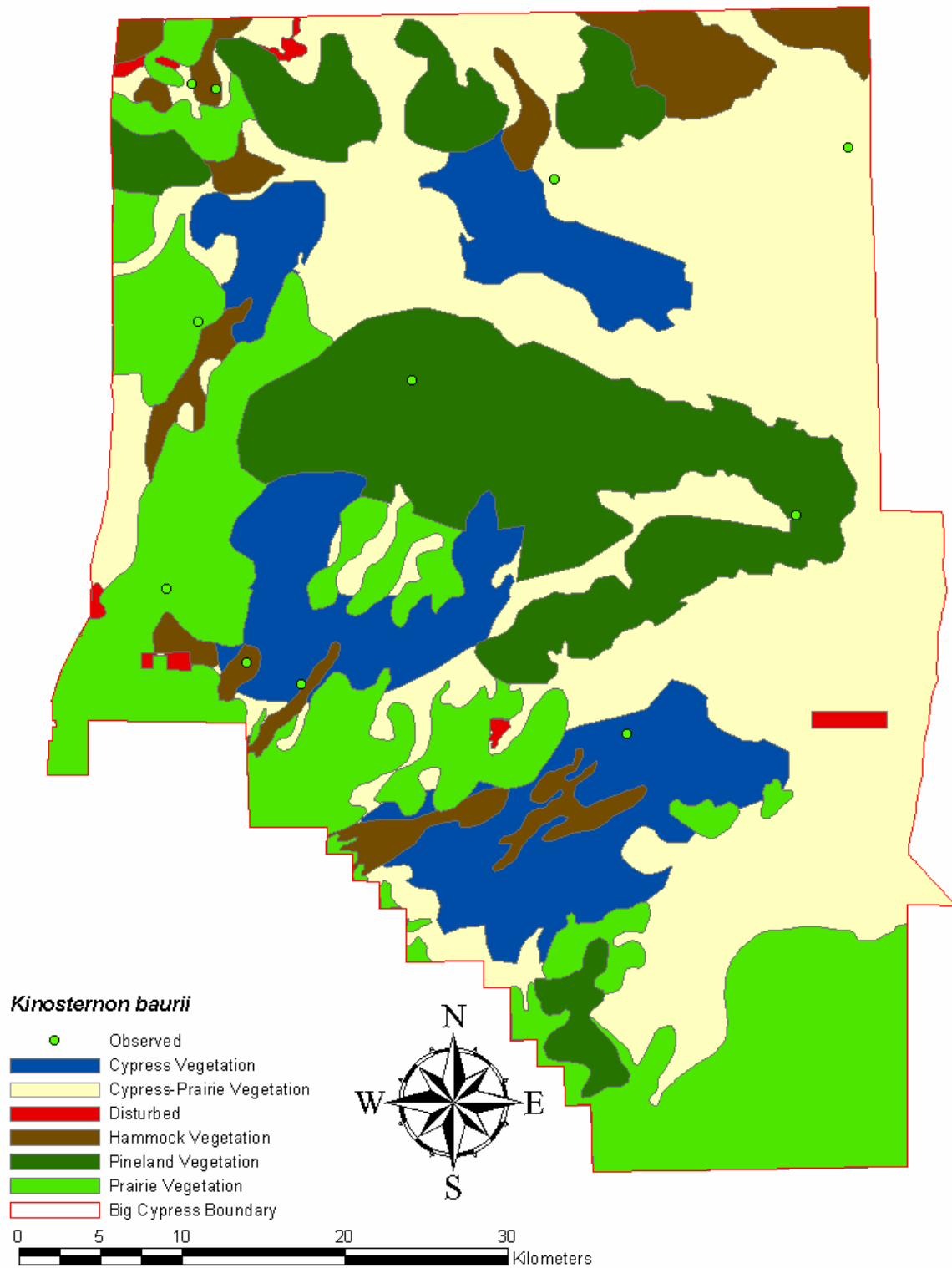
Figure 54: *Kinosternon baurii* locations.
Map of all locations at which *Kinosternon baurii* were observed in Big Cypress National Preserve.
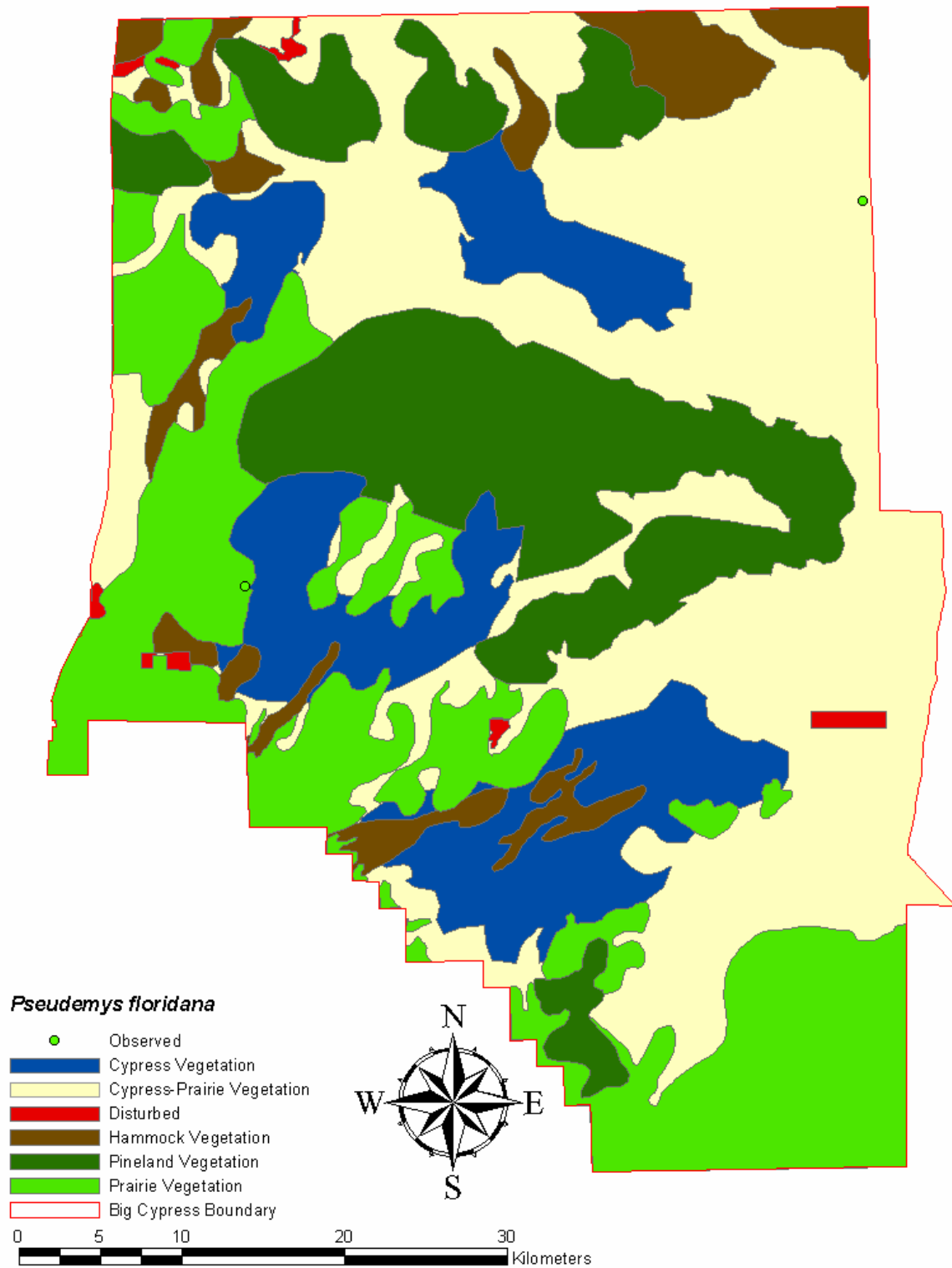
Figure 55: *Pseudemys floridana* locations.
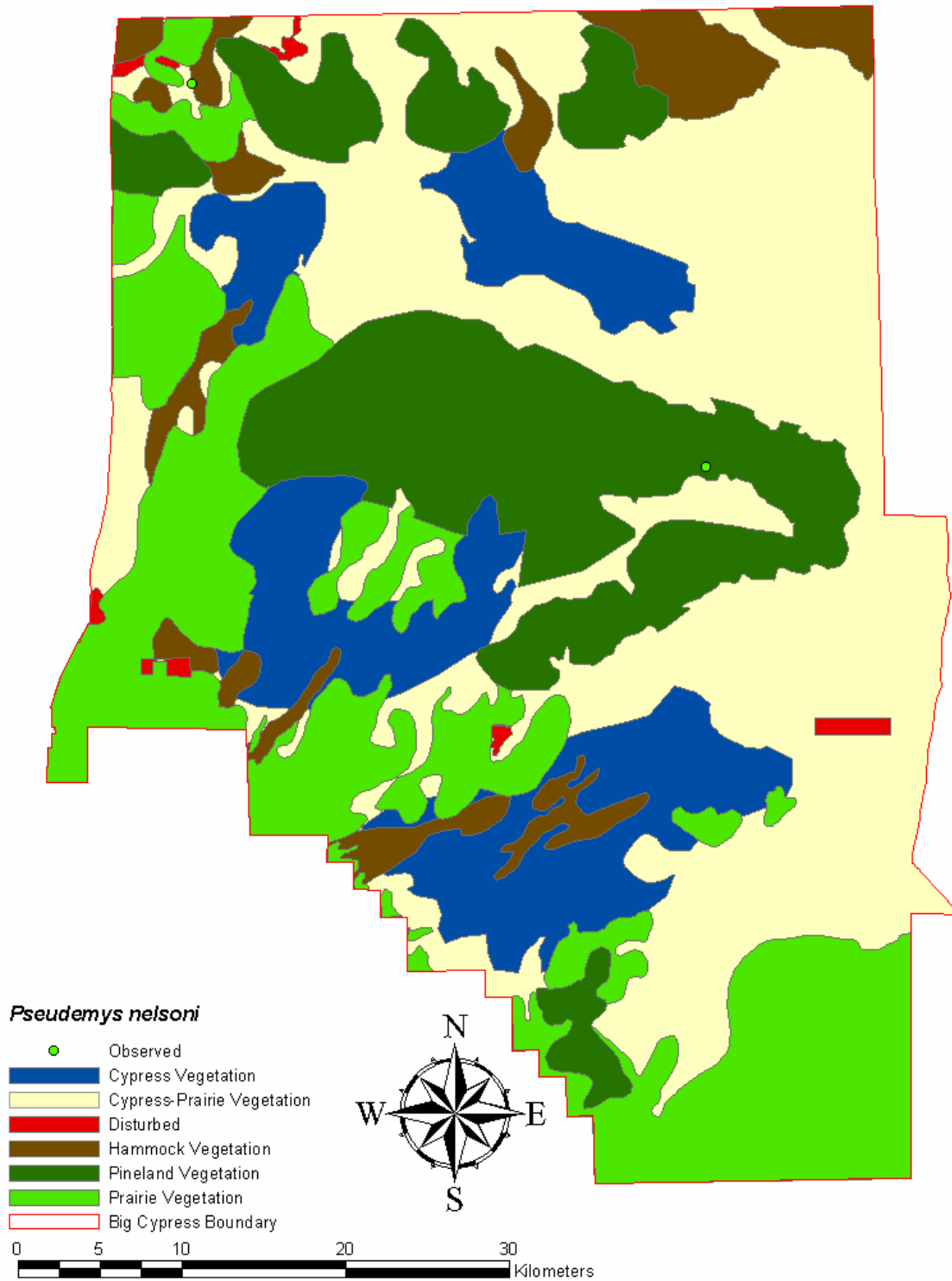Map of all locations at which *Pseudemys floridana* were observed in Big Cypress National Preserve.

Figure 56: *Pseudemys nelsoni* locations.
Map of all locations at which *Pseudemys nelsoni* were observed in Big Cypress National
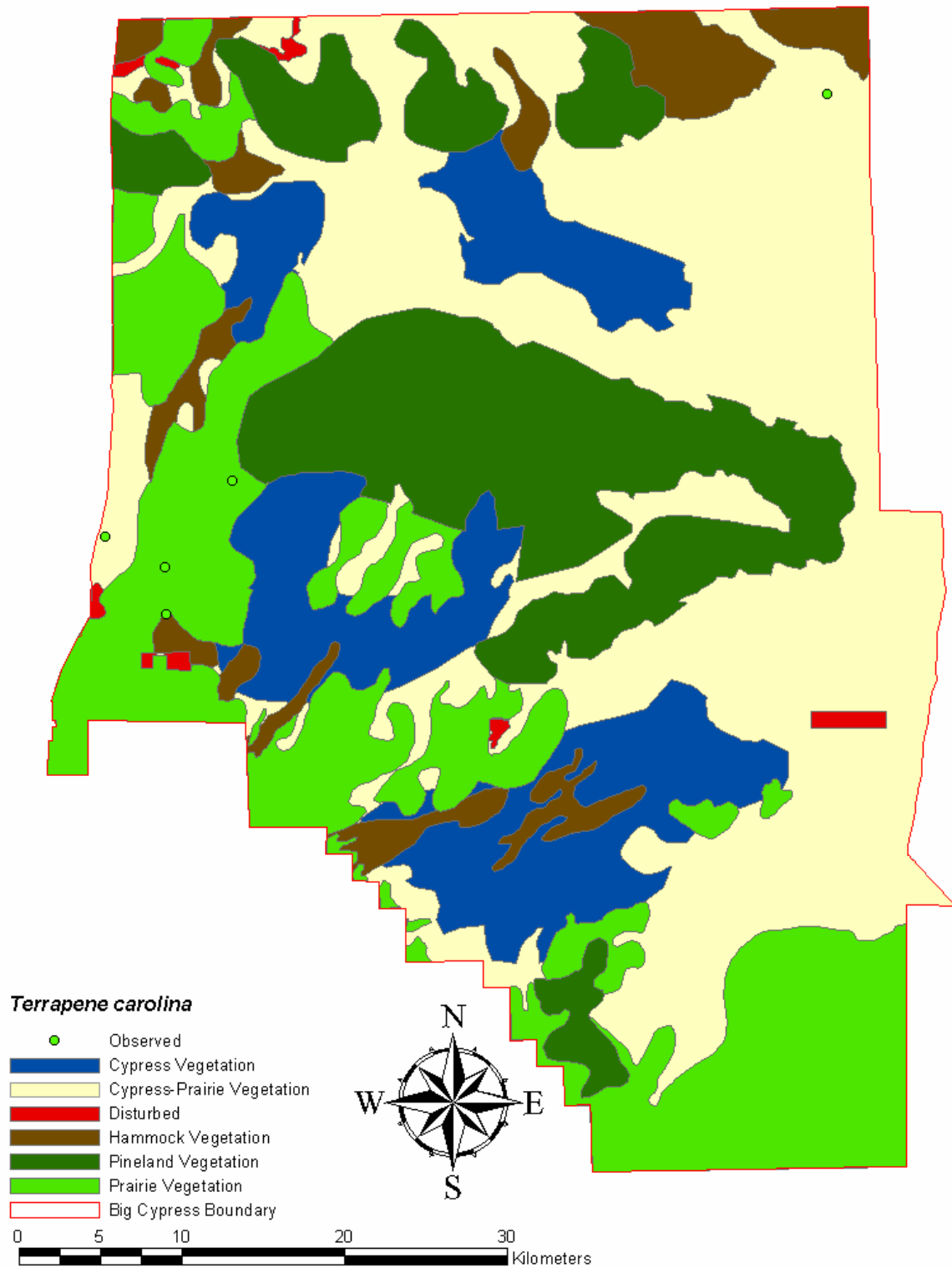Preserve.

Figure 57: *Terrapene carolina* locations.
Map of all locations at which *Terrapene carolina* were observed in Big Cypress National Preserve.